REPORT

OF THE

COAL MINING COMMITTEE

1937

VOLUME I

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REPORT

OF THE

COAL MINING COMMITTEE.

CHAPTER I.

Introductory.

1. APPOINTMENT AND TERMS OF REFERENCE.—The Coal Mining Committee was appointed by Government of India Resolution No. M. 955 of the 29th October 1936 with the following terms of reference:—

"The Government of India have, for some time, had under consideration the question of devising measures for conserving the coal assets of this country by improving the methods of extraction and preventing avoidable waste. The serious extension of fires in the main coalfields has added urgency to this problem and, by increasing the danger to life, brought into prominence the necessity of affording greater protection to persons employed in mines.

Certain emergency steps have been taken with the concurrence of the Legislature for the protection of the miners, but the Government of India have reasons to think that these are not likely to prove adequate in future years. A very large amount of coal is now standing in pillars, and its extraction must necessarily involve a larger degree of danger than is ordinarily attendant on the driving of galleries by which the bulk of the coal has been extracted in the past. It is also probable that losses of coal due to fires and collapses will in the future be more extensive than they have been in the past unless proper steps are taken. The Government of India have accordingly decided, as already announced in the Legislative Assembly, to appoint a Committee of experts to inquire into the methods of extracting coal underground and to report on the measures which should be taken—

(i) to secure the safety of those employed on this work, and

(ii) to prevent avoidable waste of coal.

"In connection with part (i) the Committee are asked to consider specially—

(*a*) the dangers arising from underground fires;

(*b*) the dangers arising from collapses of workings; and

(*c*) the suitability of the explosives in use, and of the methods of using and storing them.

" In connection with part (ii) the Committee are asked to consider specially—

(*a*) the control that should be exercised over mining methods to ensure that a substantial proportion of the coal is not rendered incapable of extraction;

(*b*) the extent to which it is desirable and practicable to enforce the partial or complete filling of the space from which coal is removed by incombustible material; and

(*c*) the manner in which the cost of any action that may be recommended should be met.

" The Committee will be constituted as follows:—

Chairman.

Mr. L. B. Burrows, C.B.E., Commissioner, Burdwan Division.

Members.

Sir Jehangir Cooverjee Coyajee, Kt., I.E.S. (retired), late Professor of Political Economy and Philosophy, Andhra University.

Mr. J. Mackie, Agent, Eastern Coal Company, Limited.

Mr. H. K. Nag, Agent, Chasnalla Coal Company.

Mr. N. Barraclough, Inspector of Mines.

Dr. M. S. Krishnan, A.R.C.S., D.I.C., Ph.D., Geologist, Geological Survey of India.

Secretary.

Mr. M. Ikramullah, I.C.S.

" The inquiry of the Committee will be limited to the coal-fields in Bengal, Bihar and the Central Provinces and its headquarters will be in Calcutta. It is expected to assemble about the end of November 1936."

2. PROCEDURE AND TOURS.—The Committee assembled in Calcutta on the 23rd November 1936, the Chairman and Secretary having spent the previous week drafting the various questionnaires (general, landlords, railways, iron and steel companies, ropeway companies and special) in consultation with the Chief Inspector of Mines. We first discussed and approved these questionnaires, drew up a provisional tour programme including the mines to be inspected, and settled the names of the witnesses to be asked to answer the questionnaires and appear for an oral examination. Leaving Calcutta on the 30th November, we were occupied till

the 22nd December visiting 25 mines in the Jharia and Raniganj Fields. One afternoon was occupied in a visit to the iron and steel works at Hirapur. After the Chistmas holidays, during which almost all of us were engaged in various lines of enquiry necessitating reading and research, we examined witnesses at Calcutta up to the 10th January. On that date we proceeded first to Asansol where we examined 13 witnesses till the 20th January. We then visited the Sarampur and Joktiabad Collieries in the Giridih Field, and three mines, including the Bokaro and Kargali Quarries, in the Bokaro Field, returning to Dhanbad on the 24th January; 17 witnesses were examined at Dhanbad from the 24th January to the 4th February inclusive. Returning to Calcutta on the 5th February, we examined more witnesses there till the 10th February when we left for the Central Provinces. Between the 11th and the 16th February, we visited 2 mines in the Pench Valley Field and 2 in the Chanda Field, and examined 7 witnesses at Parasia and Chanda. Reaching Nagpur on the 17th February, we examined one witness on behalf of the Government of the Central Provinces. Returning to Calcutta on the morning of the 19th February, we examined our last lot of witnesses till the 27th February, and then discussed our evidence till the 12th March. The discussions were complete and the recording of the decisions arrived at on the various issues simplified considerably the drafting of our Report. Each draft Chapter was sent to the members as it was completed, and the whole Report was finally discussed between the 5th and 10th April. The Committee then dispersed, and the Chairman and the Secretary saw the Report through the press and wound up all business connected with the Committee by the 20th April. Though we took rather longer than the 3½ months originally contemplated, we do not think that our work could have been completed any earlier without sacrificing much of its usefulness. There are, on the contrary, some points, *e.g.*, research, which we should have liked to examine more fully, but we hope that on the whole no important issue has been scamped, and that the arguments on which we have relied have been sufficiently documented and supported by relevant statistics.

3. MINES VISITED AND WITNESSES EXAMINED.—Altogether we inspected 34 mines and went underground at 24, the remainder being visited to see fire areas, damage to surface by subsidence, stowing arrangements, etc. The total number of witnesses examined was 72 including 11 to whom questionnaires were not sent. Questionnaires were sent to 83 persons and bodies altogether of whom 13 did not reply at all, and 9 either did not come or wish to be questioned orally. As most of the technical witnesses changed their written replies considerably under oral examination, we think that, with the possible exception of Mr. J. E. Phelps (W. No. 39) the written evidence which was not subjected to oral examination and discussion may be safely discounted, more especially as there is sufficient complete evidence on all the points involved.

4. ATTITUDE OF CALCUTTA ASSOCIATIONS.—We regret very much that the three leading Associations of Calcutta (The Indian Mining Association, the Indian Mining Federation, and the Indian Colliery Owners' Association) did not either reply to our general questionnaire or nominate representatives for oral examination. Though a few commercial firms (Messrs. Macneill & Co., Bird & Co., Jardine, Skinner & Co., Anderson, Wright & Co., Shaw, Wallace & Co., and Mohatta Brothers) did deal with our questionnaire, and send representatives for examination, they naturally did so with primary reference to their own mining interests, and we feel that these three Associations should have given us the advantage of their opinions as representative bodies. The general questionnaire was sent to all of them and the first reply was from the Indian Mining Association in letter No. 1099-R. of the 4th December 1936. Their Secretary said that, after careful study of the questionnaire, his Committee found it " impossible for them, as representing the Indian Mining Association, to answer certain questions, *e.g.*, 54 and 55, regarding which opinion among the members of the Association is likely to be divided ". The letter went on to say that " many of the questions can only be answered by individual coal companies or mining engineers, and it is understood that, in fact, this questionnaire has been issued to a number of individuals ". For these reasons, it seemed to the Committee that the usual procedure of obtaining the views of each member, and unifying them as the Association's answer, " would be useless on this occasion, partly for lack of agreement, and partly for the impossibility of replying as an Association to such questions as No. 35 ". The Committee disclaimed any disinclination to co-operate with us and added that " they would welcome a discussion with your Committee at a later stage in your deliberations when the replies to your questionnaire have been considered and your recommendations are taking form ". We were asked to " appreciate that, if these recommendations prove to be commercially impracticable, effect could not be given to them, at least with the assent of the coal trade, and possibly therefore my Committee may be able to give valuable guidance to you later ".

5. This communication was carefully considered by us and our Secretary was authorised to reply as follows in letter No. 205 of the 9th December 1936:—

> " While my Committee accepts without reservation your assurance that the decision not to answer the general questionnaire as an Association is not due to any disinclination to co-operate, but is based on certain practical difficulties, my Committee still hopes that these difficulties will not prove insurmountable. I may say, in this connection, that the general questionnaire has been sent to seven other Associations, and that, as no similar objections have been received from those Associations, it is presumed that they are sending in written replies in due course. It is not necessary for your Association to answer every question. Those questions (such

as No. 35) which cannot be replied to as an Association could be omitted, while other questions, about which opinion among your members is likely to be divided, could be answered with an indication of such differences of opinion without any definite conclusion on the part of your Association.

While your Association must of course adopt any procedure it pleases to ascertain the opinions of the members, my Committee understands that the Committee of your Association is representative and that it has the power to express opinions on behalf of those whom it represents.

The Coal Mining Committee hopes therefore that the matter will be reconsidered, and that it will not be deprived of the valuable assistance expected from your written replies as an Association and from the oral examination of two of your representatives. Even if your Association does not adhere to its previous decision, it will not now be possible for the written replies to reach my Committee by the 20th of December nor for your Association's representatives to appear for oral examination on the 2nd January 1937 as fixed in the draft programme by my Committee. There will, however, be no difficulty in extending the date for your Association's written replies to about the middle of January, the oral examination of your Association's representatives being taken early in February.

As regards paragraph 7 of your letter, my Committee is unable at present to say what procedure will be adopted at a later stage, but there seem to be certain obvious difficulties in the way of a personal discussion by my Committee with your Association as such. In the first place, it would hardly be possible to have such a discussion with your Association without also having similar discussions with other Associations representative of the coal industry and trade. In the next place, the Government of India would probably have to be consulted as to the advisability of discussing with anyone the probable recommendations of my Committee before our Report has been submitted to the Government of India or been published. Finally, my Committee finds it a little difficult to see how, if your Association is unable to reply to the general questionnaire as an Association, it would be able to discuss the probable recommendations of my Committee without previously consulting all its members or be able to speak representatively for the coal trade as a whole. If your Association is able to take this responsibility, an informal discussion, with the approval of the Government of India, may be of advantage, but in that case there should evidently be no difficulty about sending in written replies to the general questionnaire within the limits referred to above."

6. The Committee of the Indian Mining Association replied (in letter No. 55-A./1131-R. of the 18th December 1936) that

they had reconsidered the matter, but still did not find it possible to submit written replies. They also repeated their request for an opportunity to discuss informally the effects of our recommendations were likely to have on the coal trade from a commercial point of view.

7. About the same time, the Indian Mining Federation (in letter No. M. L. 2073 of the 18th December 1936) and the Indian Colliery Owners' Association (in a letter dated the 26th December 1936) declined similarly to reply to our questionnaire or send representative for examination, while making much the same request for a later discussion of our recommendations before they were finally submitted. The Indian Mining Federation said that there were technical questions and others " over which any unanimity of opinion cannot be expected ". The Indian Colliery Owners' Association, after first asking for and obtaining time to send in their written replies, said that " owing to great divergence of views amongst the members, my Committee have come to the conclusion that it would serve no purpose in doing so on behalf of the Association ".

8. Later on, the Committee of the Indian Mining Federation took the lead (in letter No. M. L. 57 of the 25th January 1937) in asking us to supply them " with purports of evidences so as to enable them to examine the same which may help the Committee of the Federation to formulate their opinion and to thoroughly discuss the whole question with your Committee ". We replied (in letters No. 632 of the 27th January and No. 648 of the 28th January 1937) that, because of the reasons given for not answering our questionnaire nor sending representatives for examination, we were unable to see any advantage to ourselves in discussing our proposed recommendations with the Indian Mining Federation as a representative body. It was added that our sittings for examining witnesses were open to the public and that summaries of the evidence were appearing regularly in the press. Copies of these letters to the Indian Mining Federation were sent to the Indian Mining Association and the Indian Colliery Owners' Association for information.

9. We have considered it necessary to cite the above correspondence somewhat fully because we believe that this is the first time that such important Associations have declined to take the responsibility of dealing, as representative bodies, with questionnaires relating to any trade or industry issued by an official committee. So far as we are concerned, these Associations have voluntarily waived both their right to be heard as representative bodies, and their claim to speak with any authority on the various problems connected with the coal trade and industry. This is unfortunate from every point of view, but the choice has not been ours. Having declined to be heard as sources of information subject to examination, these bodies could hardly expect to be heard in discussion as representative or authoritative.

10. We may add that, almost simultaneously with its first letter of the 4th December 1936 to us, the Indian Mining Association issued to all its members Circular No. 128-R. of the 5th December 1936 in which it said:—

> "While not wishing to interfere with the intention to obtain individual opinions, the Committee of the Association consider it advisable that some measure of agreement be arrived at with regard to certain points and I give below the opinion of the Committee on some of the questions. It is suggested that members might advise their mining engineers to reply on the lines indicated, provided, of course, they are themselves in agreement."

Then followed suggested replies to *Questions 23, 24, 43, 44, 46, 47, 48, 50, 51, 56, 59 and 62*. Many written replies from individual witnesses show that those witnesses were influenced by these suggestions, and we find it somewhat difficult to understand why the Association did not directly answer at least these questions and submit their opinions to the test of examination. In almost every instance, the individual witnesses who followed the Association's lead over these questions altered their views under examination and agreed, for example, that the Mines Department must be represented on the Statutory Authority, and that a case had been made out for the conservation of India's coal resources. Another significant fact is that the member firms were asked to advise their mining engineers to reply on the lines indicated provided these members themselves were in agreement. That the mining engineers employed by these firms might also not be in agreement was apparently not considered of sufficient importance to be mentioned. This is, as we have said, 'significant' because of the subordinate position of the coal industry relatively to the coal trade, a point to which we will return in greater detail in a later chapter of this Report.

11. ACKNOWLEDGMENTS.—We wish to acknowledge, with thanks, the very material assistance which we have received from the Mines Department, the Geological Survey, and the Commercial Intelligence and Statistics Department. Besides giving valuable evidence himself, the Chief Inspector of Mines has always been ready and willing to give us any relevant information he had available or could collect. We were always well received and generously entertained in every coalfield we visited, our special thanks being due to Messrs. Shaw, Wallace & Co. for their hospitality and help during our visit to the Pench Valley Field. We were strangers in a strange land in the Central Provinces, but we were made to feel quite at home, particularly by His Excellency the Governor who kindly entertained some of us at Government House in Nagpur.

12. We wish also to express our appreciation of the services of our Secretary, Mr. M. Ikramullah. He has been responsible throughout for all arrangements in connection with our tours and

meetings, has handled successfully a large mass of evidence and other information, and has also helped materially in the preparation of our Report.

13. Outlines of Report.—Our terms of reference covered the coalfields of Bengal, Bihar and the Central Provinces, but the Central Provinces will be dealt with by itself in a separate chapter and most of our Report will be concerned with Bengal and Bihar, and more particularly with the Raniganj and the Jharia Fields which are the most important in India from the standpoint both of production and of the problems we have to consider.

14. Beginning with a chapter on the history and methods of mining, our Report will go on to describe the nature and uses of Bengal and Bihar coals and the present conditions in the coal trade and industry. The problem of waste will then be considered with particular reference to collapses, fires, floods, and explosions. Next will come the problem of conservation with particular reference to the available reserves of good quality coal. Then will follow special aspects of waste and conservation, such as coal in pillars, the operations of the Coal Grading Board, and coal under railway lines, rivers, roads, etc.

15. This will complete our survey of the relevant facts and figures, and the ground will have been cleared for a chapter on general economic considerations applied to Indian conditions. Here we shall point out the practically universal trend towards State control over coal mining, and explain how rationalisation operates as a *via media* between nationalisation and free competition. This will lead naturally to the measures we recommend to deal with the situation in India. We will first suggest the further measures of control necessary over methods of first working, section-working, and depillaring. Then sand-stowing will be considered in all its aspects, *viz.*, the supplies and replacement of sand, its extraction, distribution and underground placement, the cost of stowing and the extent to which assistance will be necessary, and how, and from whom the funds are to be provided for such assistance. Finally, we shall suggest a Statutory Authority to control compulsory stowing both for safety and conservation, and shall deal with its proposed functions, constitution, and cost. A chapter will then be necessary giving full details of the additions and alterations necessary in the Indian Mines Act and Regulations. Some recommendations on miscellaneous points which have not arisen earlier will then have been made, and we shall conclude with a chapter on the coalfields of the Central Provinces and a summary of our conclusions and recommendations.

CHAPTER II.

History and methods of mining in Bengal and Bihar.

16. ANCIENT MINING.—Remains of old slag heaps within the coal-bearing areas, and such names of villages and localities as Kalipahari (black hill), Damodar (fire in womb), Barakar (big mine), and Angarpathra (charcoal-stone) indicate that in olden times coal was used for fuel and reducing iron ore.

17. RANIGANJ FIELD.—The earliest exploitation of coal for commercial purposes dates back to 1774 when Messrs. Sumner and Heatly were granted permission by Government to raise and despatch coal from a large area at Sitarampur in the Raniganj Field. Work was, however, abandoned after the first consignment of 2,500 maunds had been transported to Calcutta by river in 1775 and found inferior to English coal. No further prospecting was done until 1814 when Mr. Rupert Jones was deputed by Government to examine the area. With Government assistance, he opened mines at Egara village near Raniganj which were taken over and worked until 1835 by Messrs. Alexander & Co. and later by Messrs. Carr, Tagore & Co., both of Calcutta. In 1824, Messrs. Jessop & Co. opened mines at Damulia and Narainpur and worked them until 1839 when they were transferred to Messrs. Gilmore, Homfray & Co. In 1843, Messrs. Gilmore, Homfray & Co. and Messrs. Carr, Tagore & Co. amalgamated to form the Bengal Coal Co. which is today the most important coal-producing company in India. Messrs. Apcar & Co. were also among the pioneers in the Raniganj Field and were the first to put down shafts near Sitarampur to work the Dishergarh seam.

18. Development was slow owing to the lack of transport facilities, the only means of conveying coal to the Calcutta market being shallow and unsafe boats used during the monsoons on the Damodar River. The opening of the East Indian Railway as far as Raniganj in 1855 was followed by more rapid development, and the increasing demand for coal for railway and industrial purposes resulted in a steady increase of output. The extension of the East Indian Railway to Barakar in 1865 gave development a further impetus.

19. GIRIDIH FIELD.—In 1871, the East Indian Railway acquired extensive coal-bearing areas at Giridih and opened mines there to meet their coal requirements.

20. JHARIA FIELD.—The occurrence of abundant coal in the Jharia area was first mentioned by a Lieut. Harryngton in 1839. In 1858, Messrs. Borrodaile & Co. applied to the Court of Wards for a lease to mine coal in the Jharia estate, but no lease was granted. The first geological survey of the area was made by Mr. T. W. H. Hughes in 1866, and further attention was drawn to the Field in 1887 by Dr. V. Ball of the Geological Survey. The coalfield was next examined in 1890 by Mr. T. H. Ward on

behalf of the East Indian Railway and was then estimated to contain about 804 million tons of good quality coal. As a result of Mr. Ward's report, the East Indian Railway extended their line from Barakar to Katrasgarh in 1894 and also laid down a branch line from Kusunda to Pathardih in 1895. Mining leases were taken up by various companies and individuals, and the rapidity of development may be judged by the increase of output from 1,500 tons in 1894 to 2 million tons in 1901, and then to the largest output of any field in India in 1906. Meanwhile the Bengal-Nagpur Railway had projected a line from Midnapur to Bhojudih, but this was objected to by the East Indian Railway. The dispute was settled by the acceptance of the Weightman Report in 1901, and the Bengal-Nagpur Railway completed their main line to the Field and also constructed a line from Bhojudih to Gomoh by 1904. The completion of the Grand Chord line of the East Indian Railway in 1907 made Dhanbad an important centre of the coal trade.

21. Bokaro and Karanpura Fields.—The actual date when these Fields were discovered is not known, but they were first examined by Mr. D. H. Williams between 1846 and 1848, and were geologically surveyed by Mr. T. W. H. Hughes in 1866-67. Development of the Bokaro Field commenced in 1915 and output steadily increased from 190,000 tons in 1916 to over 1 million tons in 1922 and 2 million tons in 1928. The output in 1935 was 1,331,272 tons. Production from the Karanpura Field did not commence until 1925 and reached 424,536 tons in 1935.

22. Production Generally.—Between 1880 and 1919, the production of coal doubled every ten years, but this expansion has not been continued and is not likely to be resumed so far as can be seen at present.

23. Early methods of mining.—The earliest mining of coal in India was confined to quarrying the outcrops of thick seams, the quarries being extended to the dip until the amount of over-burden made further exploitation uneconomical. Work could only be done by daylight and had to be suspended altogether in the monsoons. Later, galleries were driven from the quarries and labour was gradually induced to work underground. The lamps used consisted of small pots containing vegetable oil and cotton wick, and the water from the galleries was carried out by women in earthenware pots. The galleries were usually of reasonable dimensions and the pillars, though small, were sufficiently strong to support the superincumbent strata at these shallow depths. As superstitious fears disappeared, night work was introduced.

24. The next stage began when the more enterprising owners realised the limitations of quarry-working, and began to sink inclines and shallow pits, and introduce winding and hauling arrangements. The head-gears consisted of two tall brick pillars supporting a wooden cross-bar and pulley, while the winding machine, known as a gin, was a vertical drum turned by animals

or women, the coal being raised at the end of a hempen rope in a large basket or bucket and water in a leather container. The area worked from each shaft was limited by the distance coal and water could be carried economically by women from the working places, a new shaft being sunk when this limit had been reached. One mine, with a leasehold of 3,500 bighas and working a seam 18 feet thick, had no less than 58 openings, the idea in those days being apparently " more holes, more coal ".

25. The expansion of railway facilities was followed by an increasing demand for coal, and this resulted in the gradual introduction of steam pumps, steam winding and hauling machinery, and more substantial headgears of wood or steel. Yet at this time the sinking of a shaft 200 feet deep was still considered a remarkable achievement.

26. PILLAR AND STALL METHOD.—On account of the comparative thickness of the seams to be extracted, the pillar and stall method of working was adopted throughout the coalfields of Bengal and Bihar, and this method, or a modification of it, has continued almost universally until now. The pillar and stall system consists of driving roadways or galleries in the seam and forming more or less rectangular pillars, one set of galleries being usually driven parallel, or almost parallel, to the strike or level course of the seam, while another set of galleries is driven more or less at right angles to the former on the full rise or dip of the seam. At first, the galleries were generally driven at the top of the seam, floor coal being then cut out until the galleries were of the full height of the seam. This occurred even where the seam was as much as 40 feet thick.

27. In order to facilitate ventilation, and to provide a maximum number of working places in a limited area, the pillars were of small dimensions, but the galleries seldom exceeded 10 feet in width. Systematic lay-out of workings was the exception rather than the rule, the galleries being set off by a sirdar or by the miner himself, and then driven without direction lines as near to the level or dip course as the miner himself could judge, the result being that the pillars were more often than not extremely irregular in shape and size.

28. Mines were, however, still of shallow depth and naturally wet, coal-cutting machines and fast haulages had not been introduced, and the quantity of explosives used for coal-getting was negligible. Danger from coal dust had not arisen, nor had inflammable gas been encountered in sufficient quantities to be a serious menace to miners using open flame lamps.

29. The final operation before abandoning a mine was to reduce the pillars to a size sufficient to support the strata above, no attempt being made to extract the coal remaining in the pillars. The leases in those days usually required that mining operations should be conducted in such a manner as not to damage the surface, and the payment of heavy compensation was usually provided for

if such damage was caused. The methods of working were thus circumscribed by the leases because the landlords considered that uninterrupted cultivation and income from surface land justified the loss of 20 to 40 per cent. of the coal. As mining methods improved, less coal was extracted in first working and pillars began to be regarded more as a reserve for subsequent recovery than a means of support. The landlords then began to demand an additional premium or *salami* before granting pillar-cutting rights. This also encouraged the maximum of extraction in first working, and was therefore unsound from a mining point of view. Such terms in leases and such demands by landlords still occur, but are not satisfactory either to the landlord or to the mine-owner, and are definitely not conducive to safety nor to the proper working of the coal.

30. Improvement in methods.—As underground workings went to greater depths, the sizes of pillars were necessarily increased, but it also became customary to make galleries from 10 to 15 feet in width. The arrangements for pumping out water played an important part in the lay-out of workings and the productive capacity of mines. Steam pumps became necessary, but their limited range of operation involved the winning of a high percentage in first working. It was also the use of such pumps, which were comparatively inefficient and a constant source of trouble and anxiety to the management, that caused much of the pillar-robbing because, when a breakdown occurred and the dip working faces were flooded, output had to be maintained by dressing or robbing pillars or by removing roof or floor coal from galleries. From about 1910, the introduction of electric pumps, with increased efficiency, unlimited range of operation and greater reliability, brought about a gradual change in mining methods and allowed the formation of much larger pillars with a much smaller percentage of extraction in first working. The subsequent introduction of coal-cutting machines into some of the larger mines also tended to reduce the incentive to obtain coal easily by robbing pillars. The introduction of electrical machinery into mines has had such a striking effect on the lay-out of workings, and the reduction of pillar-robbing, that a clear line of demarcation can be drawn on many mine plans between the workings before and after the general discontinuance of the use of steam. Steam pumps are, however, still in use in the majority of the smaller mines.

31. Increase in depillaring.—Until 15 or 20 years ago, most of the output was obtained from galleries and comparatively little pillar extraction was attempted. Most colliery managers preferred to delay this final stage of working as long as possible because they foresaw its difficulties and dangers. During the last 15 or 20 years, the percentage of coal obtained from pillars has steadily increased until it now exceeds the percentage taken from galleries. The percentage of coal extracted in first working has a direct bearing on the amount of coal that is likely to be lost by premature collapses and fires, and also on the difficulties and dangers incidental to the final operation of depillaring. At the end of

1927, a careful estimate of the quantity of good quality coal standing in pillars in the Jharia Field showed that the quantity was no less than 131 million tons. Since 1927, pillars containing 63·25 million tons of good quality coal have been extracted or lost in that Field. Both in the Jharia and Raniganj Fields, the extraction of pillars has resulted in numerous collapses and fires, and in many major accidents involving life. A later chapter of our Report deals comprehensively with the causes of such collapses and fires, and gives a brief account of the more important losses which have occurred. The quantity of good quality coal now standing in pillars in these two fields exceeds 295 million tons, about one-quarter of which is in pillars formed prior to 1928, and losses such as have already occurred are certain to recur during the future extraction of these pillars by present methods.

32. STAGES OF MINING BY THE PILLAR AND STALL METHOD.—For many years after the commencement of mining by the pillar and stall method in any coalfield, the costs of production are comparatively low because workings are at shallow depths and expensive organization and machinery are not essential. Further, major accidents involving loss of life are not likely to occur because no pillar extraction is done. Then comes the second stage when depillaring has to be undertaken to maintain output, such depillaring being usually commenced in the shallower workings. During this stage, major accidents and losses of coal by fires and collapses begin to occur. The second stage merges gradually into a third one in which as much coal is recovered by pillar extraction as by driving galleries. During this third stage, major accidents and losses of coal both increase continuously unless mining engineers take careful stock of the situation and make radical changes in their methods of working. Finally, the last stage is reached when the coalfield is approaching exhaustion and practically the whole output is being obtained from pillars. During this stage, pillars are being extracted at increasing depths and, unless advantage has been taken of previous experience to improve mining methods, the loss of life by accidents, and the loss of coal by collapses and fires, must become very heavy. In the Jharia and Raniganj Fields, the third stage has been reached and accidents and losses of coal have therefore increased very considerably during the past 10 years and may be expected to go on increasing unless radical changes in mining methods are made or enforced.

33. ACCIDENTS AND LOSSES INEVITABLE WITH EXISTING METHODS.—The extraction of pillars from any thick seam of good quality coal in the Jharia or Raniganj Field is likely to be followed by spontaneous heating and fire whether the pillars are substantial or not. In both Fields, there are seams lying one above another, and a fire in an upper seam is a constant source of danger if pillar extraction in a lower seam is attempted without stowing to maintain intact the strata between the seams. In the Jharia Field, such seams are seldom widely separated; in one part of the Field, there are three seams containing 63 feet of coal in

no more than 145 feet of strata, while in another part two seams containing 24 and 18 feet of very good coal are separated by only a few feet of strata. In the Raniganj Field, though the seams are generally more widely separated than those in Jharia, there are some areas in which similar conditions prevail. Besides, in both Fields, there are very thick and fiery seams from which the extraction of more than half the coal is not possible without stowing.

34. The greater the thickness of a seam the more hazardous is the operation of depillaring unless stowing is done simultaneously. In thick and friable seams, or seams in which cleavage is very pronounced, it is almost impossible to keep the sides secure even at moderate depths, while in seams exceeding 12 feet in thickness the testing and supporting of the roof to secure safety becomes proportionately more difficult as the height of the working places increases. Hence, during the extraction of pillars in seams exceeding 12 feet in thickness, accidents by falls of roof and side, by falling props and by wind blasts cannot be prevented even where supervision is strict and competent.

35. PANEL SYSTEM.—In order to prevent extensive premature collapses and assist the control of fires, the workings in many mines have been laid out on the panel system during the last 10 years. This modification of the pillar and stall method is worked by dividing the mine into small areas of a predetermined size, each area being surrounded by a barrier of coal through which only a limited number of roadways is driven sufficient for haulage and ventilation purposes. A fire occurring within a panel can be quickly and effectively sealed off from the rest of the mine, the stoppings required for this purpose being small in number and limited in size.

36. Our evidence discloses considerable difference of opinion regarding the merits of the panel system. Of the technical witnesses who gave evidence on the subject, 33 were in favour of the system and 4 against it. The latter included, however, the representatives of the National Association of Colliery Managers (W. No. 1) who pointed out that the panel system is comparatively inflexible, involves more waste of coal, and is no more effective for purposes of stability and fire control than the pillar and stall system provided the dimensions of galleries and pillars are satisfactory.

37. The general opinion is that, without stowing, the loss of coal in panel barriers is from 10 to 30 per cent. in addition to the loss ordinarily caused during the extraction of individual pillars, the determining factors being depth from the surface, thickness of the seam, nature of the coal and the probable period of incubation. The last of these determines the size of the panels within barriers, but it is difficult to decide what the period of incubation actually is when workings are being laid out.

38. It appears to us that the advantages of the panel system are as follows:—

(i) The factor of safety is increased in that fires can be more readily isolated, while the isolation is also more effective. Rapidity in isolating an area as soon as the first signs of spontaneous heating are observed is of great importance; the quicker the isolation is effected, the more likelihood is there of the fire being quelled before it becomes incandescent.

(ii) Panels reduce the danger of stoppings being destroyed by wind blast following falls of roof within a depillared area.

(iii) The stabilisation of pillar areas is assisted.

(iv) Panel barriers form " breaking-off " barriers and prevent weight being transferred to pillars outside the area of pillar extraction with the result that crushing and premature collapses over large areas are reduced.

39. The disadvantages of the system are:—

(i) It is relatively inflexible.

(ii) The percentage of coal lost is greater unless it is possible to reduce the thickness of a barrier, or remove a part or whole of a barrier, during subsequent extraction of pillars in the adjoining areas.

(iii) If fire takes place before all pillars within a panel have been extracted, the remaining pillars are usually lost in addition to the loss in barriers.

(iv) It has been found in practice that a subsidence does not ordinarily reach the surface unless the depillared area approximates in width and breadth to the depth of the seam from the surface. Panels should therefore be designed of such a size as to permit of a subsidence taking place to the surface within the panel so that the weight is not transferred to pillars in adjoining panels. If, however, the seam lies at a considerable depth, the extraction of all coal within such panels may not be possible within the period of incubation.

40. After carefully considering all the advantages and disadvantages of the panel system in the light of the evidence and our own experience, we are of opinion that, if principles of first working are laid down and enforced in the manner we shall propose later, the necessity for the panel system will be considerably reduced because areas about to be depillared can be flexibly isolated by stoppings. Even with the suggested principles of first working, however, it would be possible to provide barriers capable of isolating comparatively large sections or areas of a mine within which smaller artificial panels could be formed either with sand

or stoppings between pillars, the result being that, if any unforeseen difficulty or danger arose within any such artificial barrier, it could be restricted completely within the bigger section surrounded by barriers. Ordinarily, no such difficulty or danger should arise with small galleries and large pillars, and it would in such circumstances be possible to remove the barriers round the larger areas during the depillaring of the neighbouring areas. This system would enable the manager to regulate the size of the artificial panels within the larger areas in accordance with his experience of spontaneous combustion and of the normal period of incubation in that particular seam. Other advantages are that this system would be much more flexible, while the loss of coal in panel barriers would be very much lessened. In fixing the larger barriers, every advantage should of course be taken of natural barriers such as dykes and faults. Finally, we are of opinion that, where it is the intention to extract pillars in conjunction with simultaneous stowing, the panel system is unnecessary.

41. Other Fields.—The Bokaro and Karanpura Fields in Bihar and the Chanda Field in the Central Provinces also contain very thick and fiery seams in which loss of life and of coal must occur when the stage of pillar extraction is reached unless this operation is accompanied by stowing.

42. Stowing.—For many years mining engineers have known that serious avoidable waste is inevitable in extracting, by the ordinary pillar and stall method, such thick seams as are found in almost every Indian coalfield. They have also known for many years the grave dangers from accidents, collapses and fires that must accompany the recovery of tall pillars by ordinary methods. They have further known for quite as long that stowing is the only satisfactory remedy, but have not been able to apply that remedy voluntarily, except in a few cases, partly because of the general disunion in the trade, and partly because the cost was considered prohibitive under prevailing conditions of low prices and keen competition. Individual action, except under favourable circumstances or compelling conditions of working, has not been possible because of the competitive disadvantage imposed by the additional cost. Some stowing plants were installed at mines near rivers with plentiful supplies of sand, but most of them had to be closed down after the general depression made their continued working an uneconomical proposition.

43. Previous warnings of the present position.—Attention was first drawn to the losses of coal occurring in the Jharia and Raniganj Fields by Mr. R. G. M. Bathgate in 1917 in his Presidential address to the Mining and Geological Institute of India. In 1918, the Government of India engaged Mr. R. I. Treharne Rees to advise on the situation and suggest more efficient methods of working. The Coalfields Committee of 1920 followed and recommended compulsory stowing with a controlling authority

armed with legal powers. No action was, however, taken on the more important suggestions of Mr. Treharne Rees which were supported by the authoritative Coalfields Committee. Attention was next drawn to the subject in an article written by Mr. R. G. M. Bathgate in the Calcutta " Statesman " of the 11th July 1925. Shortly afterwards, the Government of India instructed the Mines Department to obtain definite information as to the quantity of coal lost by fires and collapses. Estimates of the coal so lost, and of the reserves of good quality coking coal, in the Jharia Field were prepared by one of our members (Mr. N. Barraclough, Inspector of Mines). His paper on the subject will be found in " Records of the Geological Survey of India, Vol. LXII, Part 3, pp. 377-389 ". Interest in the subject was again revived by a paper read by Mr. R. R. Simpson, late Chief Inspector of Mines, before the Mining and Geological Institute of India on the 15th April 1929. His paper was entitled " The Future of the Jharia Coalfield " " Trans. Min. & Geol. Inst., Ind., Vol. XXIV, pp. 110-114 " and said that " there is only one satisfactory method of extracting lofty pillars of coal at a depth exceeding a few hundred feet, ... and that is known as ' hydraulic packing ' and locally as ' sand-stowing '. . . . . Year by year the areas of workings lost on account of collapses and fires are extending. . . . . The time has perhaps arrived to consider whether any further steps are practicable to prevent the enormous loss of valuable coal which is inevitable under the present system of mining ". Since 1929, numerous disastrous collapses, fires and explosions have resulted in heavy loss of life and property, and have been due mainly to faults inherent in the method of working. These accidents have once more focussed public attention on the problems of coal mining in India, and the appointment of our Committee has been the outcome. In 1920, no suitable action was taken to prevent waste and preserve the coal resources because the extent of these resources was not known precisely though suspected to be small. Since then, the limited amount of Indian coal reserves of good quality has been established by a Geological Department survey, while the urgent necessity for conservation has been enforced by the even more urgent necessity for safeguarding life and property. Action by individual mine-owners is as a rule economically prohibitive, and the only effective action possible is by Government initiative and intervention.

CHAPTER III.

Nature and uses of Bengal and Bihar Coals.

44. Relative importance of Raniganj and Jharia Fields.—The coalfields of Bihar can for our purposes be reduced to the Jharia Field because almost all the coal from the Giridih, Bokaro, Ramgarh and Karanpura Fields comes from State or Company-owned railway collieries. We need accordingly only consider the Jharia Field in Bihar and the Raniganj Field in Bengal, especially as these are the most important coalfields in India from every point of view. Table I annexed to this Report shows that, in 1935, these two fields produced 78·96 per cent. of the total British Indian output. In 1920, the percentage was 83·67, but it has been just below 80 since 1928 because other coalfields in British India, and notably those in the Central Provinces, have obtained a greater proportionate share in the total output. According to the figures at page 2 of "Indian Coal Statistics, 1935" the percentage of the total Indian output recovered from the Raniganj and Jharia Fields in 1935 was 72·1, next in order being the Bokaro Field with 5·78 per cent. and the Pench Valley Field with 5·27 per cent. The predominance of the Jharia and the Raniganj Fields is therefore beyond question, and we feel justified in concentrating attention on them, more specially as the problems of safety, waste, and conservation are relatively more urgent there than elsewhere.

45. Description and uses of Coals.—The Raniganj Field is about 600 square miles in extent and begins about 130 miles north-west of Calcutta. The Jharia Field covers about 175 square miles and is about 40 miles further west. It has become customary to refer to Raniganj coal and Jharia coal as describing two separate species of the mineral, but it would be more correct to distinguish between coal of the Raniganj series and coal of the Barakar series because the Raniganj Field contains also coal of the Barakar series, while the Jharia Field contains also coal of the Raniganj series. It should be understood therefore that, when we speak of Raniganj coal and Jharia coal, we mean coal of the Raniganj (or high volatile) series and coal of the Jharia (or low volatile) series. Generally speaking, the quality of coal is determined by the percentages of moisture, volatile matter, fixed carbon and ash which it contains and also by its calorific value. Moisture of 10 per cent. indicates 200 lbs. of free water in a short ton of coal, the dispersal of which involves the burning of 33 lbs. of coal. The total loss of combustible coal is therefore 233 lbs. in every ton. Moisture is also a most important factor in spontaneous combustion. As the moisture evaporates, air takes its place and accelerates the chemical process of oxidation which causes first heating, then smouldering, and finally flame. Volatile matter consists of carbon, hydrogen, and oxygen, and the more there is of it the easier is ignition, but the greater is the smoke. High volatile content also indicates suitability for the manufacture of good gas and for hydrogenation into oil. Ash of 10 per cent. means that, for every short ton of

coal, 200 lbs. of extraneous and incombustible matter has to be raised, loaded, paid for in freight, and dealt with in firing where it clinkers in the furnaces and causes additional work. Fixed carbon is the most important constituent, while calorific value is the amount of heat given out by completely burning a unit-weight of coal, and is measured by the number of corresponding units of weight of water that are raised one degree centigrade in temperature by this amount of heat. The following are average proximate analyses of Raniganj and Jharia coals of selected quality:—

	Moisture.	Volatiles.	Ash.	Fixed Carbon.	Calories.
Raniganj .	3·92	30·77	9·74	59·49	7,236
Jharia .	1·32	24·30	11·70	64·00	7,431

According to the Report of the Coal Grading Board for 1935, moisture in good quality Raniganj coal may range from 3 to 10 per cent., but rarely exceeds 2 per cent. in Jharia coal, while volatiles range from 29 to 38 per cent. in Raniganj coal and from 21 to 30 per cent. in Jharia coal. The Grading Board classifications are, it may be added, based on ash percentage, moisture content, and number of calories, the scale varying for low (or Barakar series) and high (or Raniganj series) volatile coals. For practical purposes, Raniganj coals burn freely with a long flame and are specially suitable for steam-raising and gas-making, while Jharia coals burn slowly with a short flame and are specially suitable for manufacturing hard coke of metallurgical value. Jharia coals are, however, now admitted to be superior to the best Raniganj coals for steam-raising purposes with forced draught. Raniganj coals do not coke or only produce comparatively soft and porous coke which is of no use for metallurgical purposes with present methods of carbonisation.

46. Difference in Character of Seams.—There are also marked differences between the coal seams in the two fields. In Raniganj, the seams, though thick as compared with seams in Great Britain, are generally thin as compared with those in Jharia which are sometimes 60 to 80 feet thick and average about 25 feet. Further, the Jharia Field is congested and its 18 seams are not only comparatively close to one another, the intervening strata measuring only a few feet in some places, but are also comparatively near the surface. Finally, the best Raniganj seams are graded in their whole thickness, while the Jharia seams usually have to be graded in sections and differ in quality not only from colliery to colliery, but even within the same colliery. When it is added that several of the Jharia seams are very steeply inclined and gassy, it will be gathered that mining in the Jharia Field is exceptionally difficult and dangerous, the conditions being perhaps unique and different from anything else in the whole world. We give in Appendix B three typical sections in the best part of the Jharia Field showing the thickness and proximity of some of the seams. We also attach in Appendix C a plan, prepared partly from a plan supplied to us by Mr. J. R. Harrison, Chief Mining

Engineer to the Railway Board, showing the mouzas, some colliery boundaries and the relative position of the seams from No. 10 to No. 18 in the south-east section of the Jharia Field. There are of course nine other seams below No. 10 which are not shown on this plan.

47. OTHER CONDITIONS.—The Raniganj Field was opened about 1820 and the Jharia Field in 1893, but Jharia has been producing more coal annually since 1906, and the conditions there are relatively far more conducive to unsound and wasteful mining. The result is that serious collapses and fires have been more frequent in Jharia than in Raniganj, and the loss and avoidable waste far greater. It should be added that, with the exception of the Giridih Field, Jharia supplies the only coal which will make the kind of hard coke so far considered essential for smelting iron ore.

48. SOFT COKE.—In both fields, inferior coal (grade II and lower) and rejections from superior seams are used to manufacture soft coke, the demand for which has been nursed and strengthened by the Soft Coke Cess Committee administering the cess of 2 annas a ton imposed on soft coke despatched by rail from collieries in Bengal and Bihar by India Act VIII of 1929. During the boom period, the demand for the inferior grades of coal was good, but the slump that followed led to more and more concentrated working on superior coals, and many collieries producing inferior coals had to close down. The aim of the Soft Coke Cess Committee is to popularise soft coke as a domestic fuel. In order to establish standards of quality, supplies of soft coke have been analysed with volatile matter ranging from 2·8 to 24·8 per cent. and ash varying from 12·8 to 33·9 per cent. Loading is inspected, and extensive propaganda has been done all over India to remove the prejudice that food cooked on a soft coke fire is injurious to health. Efforts have also been made to improve the manufacturing process so as to obtain a lower percentage of volatile matter and a relatively low moisture content, and the manufacturing collieries have been put into touch with registered dealers all over India. Since operations began in June 1930, despatches of soft coke from the Bengal and Bihar collieries have been as follows:—

	Tons.		Tons.
1930 . . .	745,564	1933 . . .	823,073
1931 . . .	722,597	1934 . . .	860,478
1932 . . .	756,036	1935 . . .	888,493

49. It should be added that there are some observers who think that the expansion in the demand for soft coke is more or less artificial and dependent entirely on continued low prices for coal. If the average prices of good quality coal were to rise, they say, the demand for inferior coal would increase and its price would rise beyond the point at which soft coke manufactured from such coal can compete with wood and charcoal.

50. CONSUMPTION OF COAL.—The following are approximate estimates of the consumption of coal by various users in India taken from page 353 of Volume LIX of the "Memoirs of the Geological Survey of India" and page 10 of "Indian Coal Statistics, 1935":—

Consumers.	Estimated consumption in 1922.	Percentage of total.	Estimated consumption in 1927.	Percentage of total.	Estimated consumption in 1935.	Percentage of total.
	Tons.		Tons.		Tons.	
Railways . . .	6,186,000	30·8	7,259,000	33·5	7,293,000	31·9
Admiralty and Royal Indian Marine.	40,000	0·2	27,000	0·1	29,000	0·1
Bunker Coal . .	796,000	4·0	1,317,000	6·1	1,020,000	4·5
Cotton Mills . .	1,131,000	5·6	830,000	3·8	1,531,000	6·7
Jute Mills . . .	942,000	4·7	935,000	4·3	653,000	2·9
Iron Industry (including engineering workshops).	2,415,000	12·0	5,260,000	24·2	5,583,000	24·4
Port Trusts . . .	210,000	1·1	205,000	0·9	135,000	0·6
Inland Steamers . .	582,000	2·9	636,000	2·9	551,000	2·4
Brick Kilns, Potteries, Cement Works, etc.	437,000	2·2	565,000	2·6	792,000	3·5
Tea Gardens . .	204,000	1·0	223,000	1·0	186,000	0·8
Paper Mills . . .	147,000	0·7	156,000	0·7	171,000	0·7
Collieries and wastage .	2,471,000	12·3	2,208,000	10·2	1,220,000	5·3
Other forms of industrial and domestic consumption.	4,521,000	22·5	2,085,000	9·7	3,712,000	16·2
TOTAL .	20,082,000	100·0	21,706,000	100·0	22,876,000	100·0

CHAPTER IV.

Present conditions in Coal Trade and Industry.

51. REVIEW OF CONDITIONS.—We shall now turn from general considerations and glance at the present position in the coalfields of Bengal and Bihar. All concerned with the coal trade and industry complain that they "starve with nothing" and allege that "this doth infect the very life-blood of our enterprise". Though there have been contributory causes, such as the general economic depression, the indifference of landlords to their own interests, and the inaction of Government in the face of a growing national emergency, it is undeniable that the trade and industry is itself mainly responsible for this general infirmity.

52. It has been said that anything can be proved by figures, but it is at least equally true that nothing much can be proved without them. The following statistics (taken from Tables I to V annexed to this Report and supplied by the Mines Department and the Department of Commercial Intelligence and Statistics) may therefore be found strikingly relevant. They relate only to the Raniganj and Jharia Fields, but we have shown already that, so far as our enquiries are concerned, these two fields are of paramount importance.

	Raniganj Field.				Jharia Filed.			
	1920.	1923.	1930.	1935.	1920.	1923.	1930.	1935.
1. Annual output in tons	4,997,679	5,557,424	7,218,691	7,348,323	9,294,040	10,346,015	10,753,858	9,245,292
2. Percentage of total British Indian output.	29·26	29·62	31·82	34·97	54·41	55·14	47·41	43·99
3. Percentage of selected and grade I extracted.	75	76·1	91·5	94·8	71·7	63·0	76·9	76·8
4. Percentage of grade II and lower extracted.	25	23·9	8·5	5·2	28·3	37·0	23·1	23·2
5. Average pitmouth value per ton in rupees.	6 2 0	8 13 0	4 0 0	2 9 0	4 10 0	6 13 0	3 10 0	2 8 0
6. Average price paid per ton of coal delivered into wagons in rupees.	8 12 10	12 2 8	5 14 0	3 4 0	6 8 6	9 3 6	3 11 0	2 11 0
7. Number of mines	305	355	208	191	335	365	254	206

1920, 1923, 1930 and 1935 are key years for various reasons. The Raniganj and Jharia Fields accounted for 83·67 per cent. of the total British Indian output in 1920, 84·76 per cent. in 1923, 79·23 per cent. in 1930, and 78·96 per cent. in 1935. The boom cycle lasted till 1923, the peak years of pit-mouth value and price into wagons being 1921 and 1922. Values and prices began to fall in 1923, but production was not appreciably affected until after

1930, the peak year of output excepting 1919. The depression cycle, though usually accepted as having set in from 1929, cast its shadow ahead in the form of steadily decreasing prices from 1923 onwards, while the percentage of selected and grade I coal extracted in Raniganj rose significantly from 76·1 in 1923 to 91·5 in 1930, and in Jharia from 63·0 in 1923 to 76·9 in 1930. From 1931 to 1933, the output of both Fields fell, prices continued to drop and the proportion of superior coal extracted went on rising. In 1934 and 1935, annual outputs in both Fields recovered and advanced to the neighbourhood of the 1930 figures. In 1934, as compared with 1933, Raniganj output increased by 8·5 per cent. and Jharia output by about 13 per cent. In 1935, as compared with 1934, Raniganj output increased by 8·13 per cent. and Jharia output by 2·07 per cent. In both years, and in both Fields, these larger outputs were almost entirely of selected and grade I coal, while the average prices obtained make one wonder how the industry was carried on at all. The provisional figures for 1936 show a slight set-back in production, and this will probably continue with stricter State control over methods and the exclusion of female labour underground. Prices should, however, be relatively better.

53. CAUSE AND EFFECT OF LOW PRICES.—Economic science says that ' supply price ' is cost of production *plus* a reasonable profit, but there seems little or no margin of profit in the prices which most coal of good quality has been fetching during the past few years. These low prices are due to the interaction of keen competition and decreased demand due to the general depression. Potential production exceeds demand and competition compels the quotation of prices based on potential rather than actual production. It is common knowledge that raising costs per ton vary inversely with output, and some of our witnesses assert that larger outputs from fewer mines are responsible mainly for the very considerable decrease in costs of production which must have taken place in order to enable coal to be sold at all at recent prices. Voluntary restriction of output, with agreed-on minimum prices, has failed to materialise because the coal trade cannot combine even for obviously mutual benefit, while compulsory restriction of output, with authoritatively-fixed minimum prices, has been rejected by Government. Consequently, as a matter of economic necessity, production costs have been reduced to the subsistence or survival level, repairs and renewals of plants are limited to the lowest point compatible with safety and efficiency, depreciation cannot be provided for adequately, and new developments are comparatively rare. In 1919, there were 53 collieries under development; in 1935 the number was 12. Consumers have demanded only the best quality coal, and the temptation to raise such coal as cheaply as possible by risky and wasteful methods has been generally irresistible. This can only be justified if one admits that commercial profit is the primary consideration. The limited reserves of good coal are being rapidly exhausted, all grades below selected and grade I, and even grade I, are being sacrificed

freely, and the results must be cumulatively serious as time goes on unless some really effective steps are taken.

54. PRODUCTION COSTS.—The 1925 Committee found that the average cost of raising one ton of coal was Rs. 6 in Raniganj and Rs. 5 in Jharia, the difference being ascribed to the greater depths, smaller average outputs, and scarcer labour in Raniganj, and it is evident that, with selling prices at their recent levels, coal must have been raised at considerably lower rates per ton. We have given this point some attention in order to determine how the saving has been effected. Larger outputs from fewer collieries is one answer, but it is not the whole answer as is shown by the following figures for 1925 and 1935 collected from the companies concerned.

Costs of Coal Production.

	Company 1.	Company 2.	Company 3.	Company 4.	Company 5.	Company 6.	Company 7.	Company 8.	Company 9.
Output in tons :—									
1925	47,914	49,430	95,988	16,682	27,070	88,143	421,335	337,334	170,276
1935	125,548	136,270	227,720	192,556	141,049	443,679	531,771	338,532	116,630
Raising costs per ton :—	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
1925	5 2 1	5 2 6	5 9 7	6 15 6	4 3 2	4 14 7	4 15 0	4 3 10	4 9 3
1935	2 10 10	2 10 0	2 12 7	2 10 5	2 4 11	3 0 7	2 6 0	3 5 10	3 3 4
Remuneration of superior staff per ton :—									
1925	0 11 10	0 11 1	0 4 10	0 14 10	0 6 6	0 15 6	0 3 9	0 5 1	0 5 2
1935	0 6 3	0 5 3	0 4 9	0 4 10	0 4 5	0 8 0	0 2 0	0 4 11	0 4 6
Labour costs per ton :—									
Underground :—									
1925	1 3 6	1 2 8	2 13 1	1 7 0	1 10 0	2 5 5	4 0 3	2 5 1	2 14 5
1935	0 13 11	0 11 1	0 11 9	0 10 8	0 10 5	1 8 5			
Surface :—									
1925	0 9 0	0 8 6	0 3 0	0 8 5	0 7 3	0 7 11			
1935	0 5 2	0 2 6	0 3 9	0 2 10	0 5 2	0 3 11	2 1 0	1 14 9	1 12 11
Depreciation per ton :—									
1925	0 10 7	0 10 7	0 14 5	0 13 9	0 6 8	0 5 3	0 11 0	0 4 0	0 3 11
1935	0 2 0	0 2 0	0 3 5	0 2 2	0 2 11	0 3 9	0 3 0	0 4 0	0 4 0
Interest charges per ton :—									
1925	0 4 6	0 3 11	0 5 0	0 3 7	0 6 0	0 0 8	*Nil*		
1935	0 0 6	0 0 7	*Nil*	0 2 0	*Nil*	*Nil*	*Nil*		
Calcutta charges per ton :—								Not	Not
1925	0 8 5	0 8 5	0 4 5	0 7 11	0 0 10	0 4 4	0 3 8	supplied.	supplied.
1935	0 4 3	0 4 3	0 6 4	0 5 8	0 1 11	0 1 9	0 3 6		
Dividends :—	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.		
1925	12½	12½	*Nil*	*Nil*	*Nil*	3¾	Not		
1935	22½	22½	3¾	*Nil*	5	15	supplied.		

REMARKS.

(i) Output has risen from 1,254,066 tons to 2,253,755 tons, *i.e.*, by 80 per cent.
(ii) Raising costs per ton have fallen from an average of Rs. 5-3-0 to Rs. 2-12-0, *i.e.*, by 46 per cent.
(iii) Remuneration of superior staff has fallen on the average from Rs. 0-8-7 to Rs. 0-5-0, *i.e.*, by 41 per cent.
(iv) Total wages have fallen from an average of Rs. 2-8-1 per ton to Rs. 1-6-0, *i.e.*, by 45 per cent.
  (*a*) Underground wages have fallen from Rs. 1-9-7 to Rs. 0-13-9 per ton., *i.e.*, by 43 per cent.
  (*b*) Surface wages have fallen from Rs. 0-7-4 to Rs. 0-3-10 per ton, *i.e.*, by 47 per cent.
(v) Depreciation has fallen on an average from Rs. 0-9-0 to Rs. 0-3-0 or by 66 per cent.
(vi) Interest charges have fallen on an average from Rs. 0-4-1 to Rs. 0-1-0 or by 75 per cent.
(vii) Calcutta charges have fallen on an average from Rs. 0-5-8 to Rs. 0-4-0 or by 41 per cent.

55. The practical difficulties in studying and analysing production costs are very considerable. The accounts of about 450 mines would have to be expertly examined in order to obtain reliable data and, even then, general conclusions could be challenged on the ground of varying conditions. As the 1925 Committee did, we have had to content ourselves with figures from comparatively few large companies. Other such companies could not supply useful figures because they have changed their methods of accounting since 1925. Then, one item of expenditure is debited by some companies to capital and by others to revenue. Calcutta charges, again, do not always cover the same details, and profits are apt to be presented under the shadow of income-tax. Though our figures show a rather remarkable " concilience " in this respect, it is generally true that some companies economise more in one direction, and others in another. Finally, we have no information regarding the smaller collieries or even those of medium size. In 1935, however, the number of collieries raising up to 1,000 tons a month was 34·29 per cent. of the total number, while they produced only 3·44 per cent. of the total output. On the other hand, the percentage of collieries raising over 5,000 tons a month was only 18·70, but they produced 64·53 per cent. of the total output. The importance of the larger unit in Indian coal production has been growing steadily (in 1919, the percentage of 1,000 tons a month collieries was 49·06 and their production 6·33 per cent.) and these figures of costs are therefore a fairly good guide to general conditions. Besides, with all their limitations, our statistics are at least authentic.

56. Coming now to the figures themselves, outputs from our 9 companies increased in the 10 years from 1925 to 1935 by about 80 per cent. The companies concerned are, however, among the most important and progressive, and are all ' representative ' in the economic sense of the term. Average raising costs per ton decreased during the same period by 46 per cent., and it is remarkable how all the factors (except depreciation and interest charges) making up production costs have fallen in much the same proportion. The remuneration of superior staff has come down on the average by 41 per cent., but this includes the 10 per cent. retrenchment cut which was imposed in almost every trade and industry. It is generally considered that the superior supervising staff has been reduced to the danger limit and that changes in management have been too frequent for efficiency in work where experience of local conditions is essential. Wages of labour have fallen by 45 per cent., underground labour by 43 per cent. and surface labour by 47 per cent., the difference being probably due to work below ground being more specialised. There are of course different systems of payment, miners, loaders and trammers being paid per tub of coal, sirdars, timbermen and haulage and pumping *khalasis* receiving fixed wages, while loading and screening coolies on the surface are paid by contract. Speaking at the annual dinner of the National Association of Colliery Managers held towards the

end of February 1937, the President observed that the earnings of miners and colliery labour " are already ridiculously low and now, with the women out, the family earnings would be still lower ". He might have added that, if accidents involving large loss of life continue, the diminution in the available supply of labour may be such as to embarrass the coal industry. The efficiency of the labour has not apparently deteriorated because, according to Table 21 at page 78 of " Indian Coal Statistics, 1935 ", the quantity of coal produced annually per person employed above and below ground has increased from 113 tons in 1926 to 128 tons in 1935. Risks have, however, been taken in India which would not have been possible with less ignorant labour. The morale of the labour force was considerably shaken by the Poidih disaster particularly in the Dishergarh area of the Raniganj Field, while the exclusion of women from underground work will have a prejudicial effect numerically. It will therefore be necessary to pay labour better in any event. As was to be expected perhaps, depreciation and interest charges have fallen most of all, while Calcutta charges have decreased to the same extent as the remuneration of superior staff. The dividends paid by these particular companies have improved in almost every instance and indicate that, whatever may have happened to the property or the machinery or the labour force, the advisability of keeping the shareholders content has not been lost sight of. This may also be due to the fact that, in some cases, the remuneration of the managing agents depends on the dividends and bonuses paid to shareholders. At page 13 of " Indian Coal Statistics, 1935 " it is said that, out of 66 coal companies mentioned in the " Calcutta Stock and Share List " with an aggregate paid-up capital of 623 lakhs, 32 declared no dividend, and figures for 9 were not reported; one company paid 65 per cent., two 22½ per cent., one 20 per cent., one 18¾ per cent., one 17½ per cent., two 15 per cent., and the remainder between 2½ and 12 per cent. In these cases prices have not been too low to pay dividends, but have been too low to permit of adequate wages or improved methods to prevent avoidable waste.

57. STATUS, POLICY AND PRACTICE OF MANAGING FIRMS.—Apart from the notorious lack of co-ordination or co-operation in the coal trade as a whole, or even in the various groups into which it is divided, the managing agency system, though it may have answered the requirements of the coal trade as distributors and profit producers, has not been an unmixed advantage to the coal industry. In 1935, 74·75 per cent. of the Raniganj and Jharia production was raised by limited companies formed under the Indian Companies Act of 1913, the 1936 amendments to which do not generally apply to existing companies though there are provisions regarding the proportion of directors to be appointed by the managing agents and powers of borrowing and lending among companies under the same managing agents. These companies are directed and controlled by business firms in Calcutta described in their articles of association as " managing agents ". They are usually remunerated

either by a fixed percentage on the gross proceeds on all coal sold *plus* a percentage on other transactions, or by a commission on raisings *plus* a fixed monthly sum for office expenses, or by a fixed percentage on dividends and bonuses paid to shareholders *plus* a fixed monthly sum for office expenses. All three methods place a premium on high outputs, big sales and large profits, and are generally calculated to focus effort on immediate rather than future gain, it being remembered as well that these managing agents also control mills and other industrial concerns which benefit by cheap fuel. Shareholders seldom attend the general meetings of these companies in any numbers, two holders of ordinary shares personally present at such meetings constituting a quorum to choose a chairman and declare a dividend, while three persons holding ordinary shares, present either in person or by proxy, constitute a quorum for all other purposes. Under the 1936 amendments to the Companies Act, the interests of shareholders have been better safeguarded in several ways and closer contact between them and the directors has been aimed at. Retrenchment in working expenses has necessarily dictated policy in the coal trade, and the industry has had to give effect to that policy by increasing output or cutting down costs without sufficient attention to the mining methods necessary to secure these ends. So far as we are aware, no firm of managing agents has a technical expert on its Calcutta staff, but it is from Calcutta that the policy of every coal company is directed in detail with primary regard to commercial considerations. Some witnesses expressed themselves strongly regarding the interference of owners with mining methods. For example, the Indian Mine Managers' Association (W. No. 2) told us that managers do not at present have enough scope " because they are controlled by people who have no sufficient knowledge of mining and are liable to be dismissed if they were to refuse to carry out the orders of an owner even though the carrying out of these orders would mean unsound and unsafe working ". Others told us in confidence that they have on occasions been faced with the alternative of adopting unsound mining methods or losing their livelihood, and that, though they are held legally responsible, they do not actually have " control, management and direction of the mine " as is contemplated by section 15 of the Indian Mines Act. Some examples of the difference in the two points of view may be cited. The Report of the Court of Enquiry on a fatal subsidence at Mudidih Colliery on the 9th April 1928 says that 6 mining experts were asked for their opinions as to whether, with certain given conditions indicating every chance of premature or sudden collapse, it would be reasonable to prohibit by legislation pillar extraction in an upper seam unless the workings in the lower seam had been completely stowed. According to the Report: " The general answer of the expert witnesses is in the affirmative from the sound mining or safety point of view. It is in the negative from the commercial or profit-making point of view." Then, one Calcutta witness (W. No. 7) said before us that " the private owners (who are usually lease-holders and not proprietors) of mines

in India should be allowed to continue to mine as they please in accordance with market demands irrespective of the consequences to the property, but not irrespective of the consequences to life ". Finally, the Chairman of the Bengal Coal Co., at the last annual general meeting held on the 18th December 1936, argued that the known figures of Indian coal reserves did not necessitate any general scheme of conservation. He cited the figures of Sir Lewis Fermor, late Director of the Geological Survey as showing " that no shortage of coal in India is to be feared for over 100 years ", but omitted to mention that Sir Lewis Fermor's 100 years for the Jharia Field postulated practically complete extraction with stowing or packing. He then went on to say:—" It appears to me that the public as a whole do not sufficiently appreciate the importance of the principle involved in this question of conservation. It resolves itself into this. Are you, and all other shareholders of coal companies, quietly and peacefully to enjoy your properties as laid down in your leases with your landlords, or are you only to enjoy them subject to what Government decide you may or may not do in the presumed interest of posterity a hundred years hence? To me there can only be one answer—Government have no cause in this matter to trespass upon your rights, and I hope that upon reflection you and the public, as a whole, will agree with me." It should be added that the annual report of this Company showed—

(i) that a dividend of 12 per cent. was being paid on its shares;

(ii) that expenditure on capital account had been incurred on sinking " new pits at Banksimulla Colliery ";

(iii) that raisings for the year ending the 31st October 1936 (*viz.*, 1,173,933 tons) were " a record in our 93 years' history ";

(iv) that the export business constituted 30 per cent. of the total shipments of cargo coal from Calcutta, and that the Ceylon Government railways had purchased their coal requirements for 1937-38 from the Company instead of from Natal as had been the case during the previous two years; and

(v) that, though costs had been slightly higher, selling prices " now show encouraging signs of going up ".

58. We do not suggest that unsound methods of mining are usually followed as a consequence of the present organisation of the coal trade and industry because we have ourselves seen several mines which are being worked as soundly and as safely as present methods will permit. Nor do we suggest that there is nothing to be said on the other side because we know that companies engaged in winning and selling coal with capital belonging to shareholders have somehow to provide returns on the money invested, and are naturally concerned more with the present and near future. They have to fight for economic existence and cannot be expected to

assume in the public interest financial burdens which may result in bankruptcy. When, however, they go on to argue that it is obviously to the ultimate advantage of owners to recover every possible ton of coal and thus reduce depletion charges, our reply is that this consideration may not operate until exhaustion has so increased the value of the remaining coal as to make it worth while to conserve voluntarily, and that this point may not be reached until long after national interests have been seriously endangered or damaged. It is also evident that those responsible for sales, and particularly when their remuneration depends on the extent or gross value of those sales, are prone to force operations in order to reduce overhead charges and comparative raising costs. Hitherto, and until the temporary legislation and regulations of 1936, the Mines Department was concerned only with the safety of human life, and the general attitude of Government was that, provided the safety of workers was ensured, it need not concern itself with the safety of workings nor enforce methods of mining calculated to make available the maximum quantity of coal consistent with safety. The idea was that all this was really the business of the proprietors and should be regulated through their leases. As a result, those who control the coal trade consider, possibly quite sincerely, that their right to work their properties as they please within the terms of their leases is sacrosanct, and that they are not called on, except in their own interests, to weigh sound mining against commercial profit, nor to consider public advantage as at all relevant to the matter. In short, to use a sporting metaphor, the coal trade in India has been rather like a race in which profit has always come in first, with safety a poor second, sound methods an 'also ran', and national welfare a 'dead horse' entered perhaps, but never likely to start. Neither Government nor the landlords can escape responsibility for allowing this state of affairs to prevail for so long, but this does not alter the facts nor, still less, will it justify further inaction on the part of all concerned.

59. Suggested remedies.—It may well be asked what the remedy is. So far as the controlling firms are concerned, a new spirit of co-operation and co-ordination is the first essential. Rationalisation demands the fullest exercise of this spirit and it is evident that, without some practical exhibition of mutual trust and mutual help, no useful exploration can be done of the possibilities of voluntary restriction of outputs, selling exchanges, and regional prices. Something in the nature of a strong trade union among managers is also indicated to safeguard them against arbitrary dismissal and to ensure reasonable continuity of employment in the same mine. So far as Government is concerned, the measures of State control suggested later in this Report must tend to eliminate gradually most of the disastrous consequences of past policy and present conditions. Even so, steps should also be taken to enforce more practically the responsibility imposed on owners by section 16 (1) of the Indian Mines Act. They are supposed to be respon-

sible that all operations are conducted in accordance with the provisions of the Act, regulations, rules, bye-laws and orders, and are also supposed to be equally guilty of all contraventions unless they have taken reasonable measures to prevent them. Actually, provisos (*a*), (*b*) and (*c*) almost completely divest both owners and agents of legal liability, and we would therefore amend these provisos so as to make it clear that they are legally liable if it can be proved that the offence or contravention has been committed in order to comply with an owner's or agent's general or particular instructions regarding reduced costs or increased outputs. We would also require that, as agents are superior to managers under section 3 (*a*), all agents must have at least the qualifications of the managers working under them. These qualifications are prescribed in section 15 of the Act and in Permanent Regulations 23 and 33 to 37.

CHAPTER V.

The Problem of Waste with particular reference to Collapses, Fires, Floods and Explosions.

60. ACCIDENTS IN COAL MINES.—Public attention has been drawn to the coal trade and industry because of the serious mining accidents which have occurred one after the other during the last two or three years. Though the significance of these accidents should not and cannot be overlooked, while their relevance to our enquiries has been emphasised in our terms of reference, it should not be forgotten that there are other, and in some ways more solid, grounds for State intervention to prevent avoidable waste of an irreplaceable national asset. No country can afford to have a valuable asset wasted and the prevention of such waste becomes imperative when the asset is limited in quantity. It has been argued that no drastic measures against waste are required because there is no guarantee that men will always need coal, but it is at least as pertinent (or impertinent) to reply that no one can predict what further uses may be found for coal in future.

61. Some accidents in coal mines are directly connected with wasteful methods and practices. Where, for instance, excessive extraction in first working has left pillars inadequate for support, various consequences may ensue. Crush and premature collapse may lead to a sudden subsidence and lives may be lost both above and below ground. Further, much valuable coal may be lost and dangerous fires caused by spontaneous combustion may follow. Other accidents have no connection with methods of work as, for example, fires caused by upsetting an open lamp or explosions caused by tampering with a safety lamp. Accidents are bound to happen in the best regulated industries because one cannot legislate against human incompetence or carelessness, and coal mining is, and must always remain, a dangerous occupation. This does not mean, however, that no steps should be taken to prevent conditions arising which cause accidents or magnify their consequences.

62. FIGURES OF RECENT FATAL ACCIDENTS.—The following figures of fatal accidents in coal mines during 1934 and 1935 are taken from the Annual Reports of the Chief Inspector of Mines:—

Year.	No.	Deaths underground.	Deaths on the surface.
1934 . .	131	140	17
1935 . .	158	252	12

Of the 1934 underground deaths, 61 occurred in Jharia, 50 in Raniganj and 13 in the Pench Valley; of the 1935 underground

deaths, 106 occurred in Jharia, 67 in Giridih, 46 in Raniganj and 18 in the Pench Valley.

63. EXAMINATION OF RECENT FATAL ACCIDENTS.—The more serious accidents in the last few years have been referred to by one or two prominent members of the coal trade as pure accidents. We presume that a " pure accident " is one that is not only beyond human foresight and control, but is also not contributed to in any way by human incompetence, negligence or rashness. The idea meant to be conveyed is that Nature was entirely responsible, and that these accidents occurred because " Nature is in a troublesome mood ". Let us now see how far such statements are true by analysing the fatal accidents of the last three years as described in the Annual Reports of the Chief Inspector of Mines.

1934—Poriapur Colliery—6 killed.—Only the bottom 12 feet of the 34 feet thick seam was being worked. A pillar 50 feet square was being extracted by a split of 24 feet leaving stooks on either side. The miners were killed by the fall of an unsupported shale band 18 inches to 2 feet thick. The Inspector of Mines who enquired into the accident considered that it was one which should not have occurred and that, though the deceased disobeyed orders, the main responsibility rested with the night and day shift overmen because the place was unsafe and more props should have been set.

1934—Seebpore Colliery—5 killed and 1 injured.—The seam is 15 feet thick and 250 feet from the surface. Pillars 60 to 70 feet square were being extracted by driving two splits forming four stooks. The miners were overwhelmed by a fall of roof while removing loose coal from a fenced-off goaf. This was against orders and contrary to the Regulations.

1935—Bagdigi Colliery—19 killed and 7 injured.—A Court of Enquiry was held under section 21 of the Mines Act. No inflammable gas had ever been detected and open lights were being used. A retaining wall protecting the mine from a large tank and nullah collapsed during heavy rain. A large quantity of water was suddenly admitted into the upper seams which were on fire. It was considered that this water generated gases and produced a reversal of the air in the mine which gradually filled the workings with an inflammable mixture of air and gases. This mixture was ignited either from the fire in the upper seams or by the naked lights of the five persons who were entombed in the mine. The explosion may have been extended and its force augmented by dry coal-dust on the haulage roads and rise workings. It is our view that, though the collapse of the wall may have been a " pure accident ", the consequences would not have been serious if there had been no fires in the mine. These fires were caused by the extraction of pillars in thick seams without stowing, and also by extracting pillars under a fire area, a practice which has since been prohibited by regulation.

1935—Joktiabad Colliery—62 killed.—The accident was caused by an ignition of coal-dust by flame from a blown-out shot of

liquid oxygen explosive. The mine was non-gassy and worked with naked lights. The Court of Enquiry under section 21 of the Mines Act found *inter alia* (i) that the shots were not well placed and that at least one of them appeared to have been improperly stemmed, (ii) that the number of persons in the district was much greater than it ought to have been, (iii) that the miners were allowed to congregate much too close to the shots, (iv) that it was a mistake to have the same official firing the shots and supervising the district, and (v) that it was doubtful whether the place had been watered at all before the shots were fired. We may add that, as a result of this accident, various regulations were introduced regarding additional precautions to be taken during shot-firing and against coal-dust.

1935—Loyabad Colliery—11 killed.—This accident was enquired into by an Inspector of Mines and his report was published by the Local Government. An irruption of water from old workings caused the accident. The plans were inaccurate and there was no proper knowledge of the actual extent of the workings. There had been too many changes of management at the colliery, and the system of making, maintaining, copying and comparing plans was found to be defective. Provision was made against similar defects occurring in future by amending the bye-laws.

1936—Loyabad Colliery—35 killed and 23 poisoned by gas, but recovered.—The Court of Enquiry under section 21 found that the fire was "almost certainly due to spontaneous combustion or to an accidental fire, but we think the latter rather more probable than the former". This fire ignited unconsumed gases driven back over it by a fall of roof, and two explosions occurred in this way. Of the 35 fatal casualties, only 14 were engaged in fighting the fire. The other 21 were in the dip workings removing pumps, and were not withdrawn although the Chief Inspector of Mines had insisted that no one should be employed underground except those dealing with the fire. As regards the fire itself, the Court found that the stoppings made or planned were well-placed to exclude air from the fire, and that the rescue measures were as efficient as possible with the equipment available. Most of the Temporary Regulations issued with Notification No. M955 of the 23rd May 1936 were introduced as a result of this accident.

1936—Second Adjai Colliery—4 killed and 1 injured.—The mine had been shut down and flooded for some years. It had been dewatered shortly before and was being inspected prior to work being restarted. No gas had ever been found in the mine which had been previously worked with naked lights. The fatal explosion was caused by gas being ignited by an open lamp carried by one of the party. The proper examination of re-opened mines with safety lamps has since been prescribed by regulation.

1936—Niluripatra Colliery—4 killed.—Pillars in a seam 40 feet thick, lying at a depth of about 80 feet, suddenly collapsed in an area 300 feet × 200 feet, and persons on the surface were engulfed

in the subsidence. The premature collapse was due to the excessive size of galleries, some of which were as much as 30 feet high.

1936—North Burrakur Lodna Colliery—3 killed.—Pillars in an area 300 feet × 350 feet, adjoining a depillaring area in a seam 24 feet thick, collapsed and an occupied dwelling was destroyed by the ensuing subsidence. In the collapsed area, the pillars were 45 feet square and the galleries 12 to 15 feet wide and 24 feet high. Had the galleries been of moderate height, the premature collapse would not have occurred.

1936—Poidih Colliery—209 killed.—A Court of Enquiry under section 21 has been held, but its report has not been published yet. As both shafts were sealed down within a day or two of the disaster, the cause of the obviously terrific explosion must in any event be a matter of conjecture. It is known, however, that over 50 women were killed who should not have been down the mine at all. It is generally believed that inflammable gas was expelled from a goaf and that the explosion was propagated through the mine by coal-dust. We deal with this question further at the end of Chapter IX.

64. MEANING OF WASTE.—Besides endangering and destroying human life, the ordinary methods of working are often unnecessarily wasteful. It should be clearly understood that by 'waste' we mean underground waste and not waste caused during any process of distribution or consumption subsequent to extraction from the mine. Except for occasional collapses, waste does not occur during first working because all the coal is raised, while the coal left in the roof or floor or in panel barriers is still recoverable later. It is during depillaring that most waste occurs, and its extent varies with the thickness of the seam, depth from the surface, nature of the roof and of the coal, and sizes of galleries and pillars. If the galleries are high and wide, and the pillars comparatively small, crush may set in and be followed by premature collapses and fire involving waste amounting to millions of tons. On the other hand, when the seam is thin (up to about 12 feet) and the pressure comparatively small because the surface is near or the roof strong or the coal hard, only a little coal may be lost in depillaring. We estimate that, taken over the Raniganj and Jharia Fields as a whole, the average waste in the working sections of seams is 35 per cent. The waste owing to sections not being worked for commercial reasons is about 15 per cent. The average total waste of coal *in situ* is therefore about 50 per cent. of which all but 10 per cent. at the outside would be saved by stowing. There must probably always be this 10 per cent. of waste in boundary barriers, shaft protection, etc., to keep a mine safe. The 50 per cent. is made up of 15 per cent. in sections left, 15 per cent. in barriers, 15 per cent. in actual depillaring, and 5 per cent. in fires and collapses.

65. MEANING OF AVOIDABLE WASTE.—The term "avoidable waste" has been debated by mining men for years, and it has of course a relative meaning varying with the method of working,

the local conditions and the standpoint of the speaker. Almost all our witnesses have, however, accepted the following definition:—"Avoidable waste is all waste which is not incidental to a proper and efficient working of the system of mining that is being followed." This is an adequate definition from a mining and national point of view, but a commercial man would say that market conditions must be taken into account and that it is not avoidable waste to leave behind and lose coal which he cannot at the moment extract at a profit nor use to industrial advantage. This is where the fundamental clash comes and it is for Government to decide which view is to prevail and determine its policy. So far as we are concerned, we are definitely of opinion that the commercial aspect must be subordinated to the national and mining aspects, if there is to be any reality in a policy of 'safety first', *i.e.*, safety which safeguards human life from danger, and safety which protects coal of good quality from avoidable waste.

66. CAUSES OF AVOIDABLE WASTE.—In considering the question of avoidable waste, we would distinguish between:

(i) Waste due to mining methods which are bad under all circumstances, *e.g.*, too high a percentage of extraction in first working and enlarging galleries or reducing pillars too much in advance of systematic depillaring.

(ii) Waste due to mining methods which have been more or less forced on the trade and industry by economic conditions, *e.g.*, section-working involving the sacrifice of coal of commercial or industrial value.

(iii) Waste due to circumstances over which the mining community has little or no control, *e.g.*, coal lost

(*a*) as support under railways or other surface features,

(*b*) in excessive barriers due to crooked boundaries or small leaseholds or geological disturbances such as faults, and

(*c*) because terms in some leases encourage excessive extraction in first working, or hinder agreements regarding depillaring, way-leave and boundary adjustments for which big premiums or transfer fees are demanded.

67. ALL AVOIDABLE WASTE SHOULD BE CONTROLLED.—We think, however, that national interests require that all kinds of avoidable waste should in future be strictly controlled, and prevented as far as possible, by various measures to be recommended later. Government should decide definitely, and then declare firmly, that safety of property comes only second to safety of life, and that control over all concerned in the coal trade and industry will be strengthened by laws and regulations intended to safeguard the mineral as well as the miner. It will be argued that avoidable waste occurs in all coal-producing countries and the somewhat impressive figures of the United States of America Coal Commission may even be cited. That Commission calculated that, in 1921, the United States of

America produced 368 million tons of bituminous coal and that, in recovering this amount, 196 million tons were wasted out of which no less than 110 million tons was avoidable. In other words, out of 564 million tons *in situ*, 65·2 per cent. was recovered and 34·8 per cent. was wasted, the percentage of unnecessary waste being 19·5. It should, however, be added that, in the early days of mining in the United States, the percentage of coal recovered was only 27; the Coal Waste Commission of 1893 gave the average percentage of recovery as 41·5; by 1921, it had increased to 65·2 per cent. We have not been able to ascertain what the percentage is now, but the point is that the percentage of recovery in the United States of America improved steadily as experience was gained, whereas in India the average percentage in 1920 was 66·6 (see paragraph 12 of the 1920 Committee's Report) and is now only 50.

68. COLLAPSES, NORMAL AND PREMATURE.—We shall now deal with some particular aspects of waste, the first of these being collapses. Collapses are either normal or premature. Normal collapses are brought about deliberately by roof control, the procedure being to remove as much pillar coal as practicable, withdraw the timber props and bring down the unsupported roof periodically. Such collapses are an everyday incident and cause little or no immediate danger because, even when a main fall breaks up to the surface after local falls have been delayed and a sufficiently large area has been depillared, there is usually sufficient warning to allow of miners being withdrawn, defensive stoppings being provided and surface buildings being evacuated. Premature collapses, as the adjective implies, occur involuntarily before working conditions are ready for normal collapses. They are comparatively sudden and sharp, and may have devastating results to life and property both underground and on the surface.

69. CAUSES AND DEVELOPMENT OF PREMATURE COLLAPSES.—The causes and development of premature collapses have been well described by the Second Subsidence Committee, which consisted of eminent mining engineers, was appointed by the Mining and Geological Institute of India, sat from 1929 to 1935, and made enquiries from agents and managers actually engaged in developing and depillaring. The following extracts from their Report "Transactions of the Mining and Geological Institute of India, Volume XXXI, Part 2" will be more enlightening than anything we could say on the subject.

"From the moment the coal is attacked and pillars are formed, the process of decay of strength to meet the load of the superincumbent strata, leading ultimately to collapse, is initiated. The very reduction of the bulk of a coal seam increases the static stress on the remainder, and the driving of galleries allows the development of lateral stresses in the coal of the pillars, resulting in a weakening of its capacity to bear the weight of the overlying strata. In virgin ground the stresses in the coal and the overlying strata are normally in equilibrium; the development of the mine

working is an attack on that equilibrium and, as that attack progresses, stability is impaired."

* * * *

" It is evident that early in the life of the coal pillars the processes of disintegration are operating, but coal seams vary considerably in their powers to resist these early inherent deteriorating forces, and what may be true of a seam in one colliery may not apply to the same seam near by, particularly so if effected by tectonic movements. The effects so often described as weathering must, therefore, be a most variable factor."

" It has been shewn that the deterioration in strength of the pillars commenced from the first attack on the coal seam. Further reduction of the bulk of the coal in the seam immediately reacts to the detriment of the strength of the coal that remains behind, and gives greater play to those forces tending to disturb the stability of the mine. Heightening of galleries, either by cutting the roof or the floor, increases the lateral stresses and allows roof pressures to operate laterally more extensively on the pillars along their heightened sides and thus promotes spalling. Widening of the galleries, since it always results in unequal roof spans, causes further stresses in the roof and initiates incipient breaks. Splitting and robbing further reduce the bulk of coal supporting the roof weight, and additional weight is thrown thereby on the reduced pillars causing further spalling, which spalling, so well-known in our mines as ' fallen coal ', still further reduces the bulk of the coal seam available to support the roof."

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" It may not be out of place to remark that the matter of pillar strength has two distinct phases, *viz.*, (1) the conditions of stress during whole workings, and (2) the conditions of stress during pillar extraction, when unattacked pillars will be called upon to resist the enormous forces set up by the intermittent adjustments of subsiding strata over the area of extracted pillars, producing incipient, and perhaps actual, dynamic loads. The unit pillar strength required during depillaring is greater than is required in ordinary whole workings, and it is essential to plan the size of pillars for the loads of the depillaring phase, keeping well in mind the deteriorating forces that act continuously and cumulatively on the pillars during their whole life. The consensus of opinion is that the deterioration of pillars is due chiefly to mechanical stresses, and that when continual spalling does take place, the pillars are already considerably stressed by roof pressure, and that the spalling is simply relief to these stresses consequent on the normal spread of stress from the loaded area. Such relief is local to the spalled coal and, when this spalled coal falls, still greater strains are set up in the remainder of the pillar, resulting in fresh spalling and a further loss of strength. Avoidance of this destructive stressing is best possible by designing large pillars in the first instance."

"The nature and the continuity of roof strata have a very considerable effect on the question of deterioration of coal pillars."

* * * *

"As development proceeds, wider areas of roof are involved and fractures develop higher in the strata, increasing thereby the load on the coal pillars. Experience shews that this loading is at times concentrated in the interior of pillars as there the coal sometimes appears to be more friable, producing less lumpy coal than the outer sides of the pillar. It may be stated, however, that if the pillars are large enough they will satisfactorily resist the roof load of the first workings, even when—as evidence shows—the pillars have been robbed to a very considerable extent and, so long as the load remains static, the position will remain one of equilibrium for perhaps considerable periods. Once depillaring starts, however, the static load may become dynamic, and the position may immediately become unstable. What is safe in open workings therefore, may become very definitely unsafe when depillaring begins."

"There is, however, always the possibility of failure of a single pillar, in cases where the pillar strength has little margin of safety. Such fracture sets free the static forces, and adjacent pillars are immediately overburdened by the dynamic load and collapse is initiated. Where collapses have taken place in mines in the whole workings, these are probably due in most cases to the failure of single pillars. Such initial failure may be the result of extensive robbing or may be by the concentration of roof stresses set up either by the inequalities in the mechanical strength of the roof, or by localisation of pressure due to the presence of faults, dykes, or roof breaks, or again it may be the result of the varying strength of the floor. It is the practical experience of most mining engineers in India that some pillars do appear to be stressed more than others, that is, there would appear to be some localisation of roof pressures. Indeed, when the varying character of the roof rock is realised, it is easy to understand how pillars must be unequally stressed."

"Faults and dykes greatly affect the strength of pillars in the vicinity. It is known that faults may concentrate or may distribute rock pressures. * * * The effect of faulting usually results in added roof pressures, sometimes of considerable extent, and this is the consensus of views expressed in replies to the questionnaire. Similar remarks apply to dykes. These cause breaks through the roof rocks and they are always accompanied by subsidiary and parallel slips, often repeated some distance away. These slips are caused by the stresses set up by intrusion under considerable pressures of the molten magma of the dykes, and of the contraction that accompanies its subsequent cooling. Such slips are a source of great danger and, by breaking the roof vertically, often localise considerable pressures on the coal pillars."

" Intrusive sills in the superincumbent strata may considerably affect the loading of the pillars by distributing pressures. * * * * * *."

" It is apparent that the forces tending towards the demolition of coal pillars in the first workings, more particularly in the thick seams, are considerable and with age are cumulative. With this in mind the Subsidence Committee would again emphasise the need of substantial pillars in the first working with galleries of a height not exceeding 10 feet. They would, in particular, emphasise the weakening effect of the presence of faults and dykes on pillars, and especially so in such instances where faults or dykes intersect. In view of the cumulative effect of the forces causing stresses within both the coal and the attendant strata, it is advisable, in order to ensure maximum extraction, that depillaring should not be long delayed after the first working."

" When depillaring is commenced, the whole situation is changed. So long as the pillars in the ' whole working ' phase of extraction are of sufficient strength, no collapse is to be feared, but experience has proved that their strength may become greatly impaired, and the situation may become one of more or less balanced equilibrium where, so long as the load remains static, the workings remain stable."

" By removing the coal in depillaring, an additional weight has to be supported by the pillars that remain in the vicinity; for a while this increased weight is borne by these pillars, but the stressed rocks over the void will eventually bend downwards and exert a pull on the roof and the top of the coal pillars in the vicinity towards the centre of the extracted area, until the roof rocks suddenly fracture and fall. This affords relief to the lowermost beds, but with some rebound, and then a measure of relief to the coal pillars supporting the span. The successive rock-beds above will break similarly and each fracture will set up a certain rebound. This will continue until, providing the span of depillared area is sufficient, the breaks reach the surface and subsidence occurs. * * * * *."

" When a surface fall takes place there is usually relief on the pillars, and the rock edges around the periphery of the fall will receive some support from the debris of the surface fall, which by its weight will become packed against the fractured sides. As the depillaring operations extend, the fractured edges will find considerable support from the debris of the fall before the second break to the surface occurs. The back pillars are thus being alternatively loaded and unloaded and, so long as their strength is sufficient to withstand the stresses so set up, no collapse occurs. If, however, their strength has no great margin of safety, a weak pillar will eventually give a little under load and its sudden failure will suddenly throw heavy pressure on one of more other points. The static load will then change to a live load with disastrous results, over-riding all weak pillars in the vicinity, and throwing

such dynamic stresses on strong pillars that they, too, become involved. Once such collapse is started, it is difficult to stop and, often when stopped, will become operative later. Collapses start similarly where no depillaring has been done, but where the pillars have been so reduced that a weak pillar may suddenly give under load in the proximity of other weak pillars, and the static load of the roof, may, in consequence, become dynamic."

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"It will be seen that the avoidance of collapses in depillaring is very much a matter of planning ahead. The percentage of extraction in the first working should be strictly limited, the height of galleries being similarly controlled. The working should be arranged on the panel system, localising areas, and the work should proceed rapidly on an even line of face established to the best advantage for roof control relative to the roof joints. Irregularities of all kinds should be avoided, and special care should be taken in the proximity of faults and dykes."

"Unfortunately a very large proportion of the workings in the Indian coalfields, particularly in the thicker seams, do not satisfy these conditions and the curve of maximum extraction, based on actual practice, suggests that in many of the mines a greater percentage of extraction has been carried out during the first working than appears advisable. Past experience in the Jharia Coalfield also suggests that much of the existing whole workings have no great margin of stability, and that depillaring would set up considerable collapses therein."

"To meet such cases, it would appear that nothing but complete stowing with sand is likely to be really effective."

70. DANGERS FROM COLLAPSES.—There can be no doubt that the danger of premature collapse actually exists in most of the areas in which coal is standing in pillars. The usual dangers from such collapses are:—

(i) underground accidents following falls of roof and side, and parts of pillars;

(ii) surface accidents due to tenanted buildings being destroyed by subsidence after sudden collapse underground or because the extent of an expected collapse has been incorrectly estimated;

(iii) underground casualties from air blasts, inundations of water, expulsion of noxious or inflammable gas, and mine outlets being cut off or damaged;

(iv) damage to fire stoppings and to protective and boundary barriers; and

(v) the crushing of coal leading directly to spontaneous combustion and destructive fires.

71. REMEDY FOR PREMATURE COLLAPSES.—As collapses are due to instability, the obvious remedy is to guard against unstable

conditions by limiting extraction during first working and leaving smaller galleries and larger pillars. Where instability already exists, weak pillars should be stabilised by stowing round them. Further, all reduction or splitting of pillars and all heightening or widening of galleries should be prohibited until systematic pillar extraction is about to begin, and such pillar extraction should either be accompanied by stowing or be strictly controlled.

72. According to Mr. N. Barraclough's paper on "Coal Resources of the Jharia Coalfield" (Records of the Geological Survey of India, Volume LXII, Part 3, pages 377-384): Unless sand-stowing is adopted, a considerable quantity of coal will, most certainly, be lost in the area lying between Kirkend and Angurpathra villages where Nos. 14 and 13 seams are separated by a thin band of shale varying in thickness from 4 to 12 feet only. In this area, No. 14 seam is from 25 to 30 feet in thickness and contains about 105 million tons of coal, of which 19 million tons are standing in pillars. In No. 13 seam, the thickness of which is from 18 to 20 feet, there are 86 million tons of coal available and 10 million tons are standing in pillars. Almost all the coal which is standing in pillars in No. 13 seam lies beneath the developed workings in No. 14 seam. At several collieries where both seams have been developed, the coal standing in pillars in the lower seam has been lost when attempts have been made to depillar the upper seam. The band of shale separating the two seams is too thin and weak to resist the blow when the roof breaks down in the goaf of the upper seam, with the result that the galleries in the lower seam are filled with debris". This prediction made in 1927 has been fulfilled because a considerable quantity of coal has since been lost, not only in No. 13 seam, but also in No. 14 seam, and further loss will certainly occur unless stowing is adopted. The extraction of pillars in No. 14 seam has been followed almost invariably by premature collapses and by fires. Even where No. 14 seam has been extracted without damage being done to No. 13 seam, below, the fire which has followed pillar extraction has rendered No. 13 seam unworkable.

73. Connection between premature collapses and fires.—According to the Second Subsidence Committee, "experience has very firmly established the relationship of underground fires to the extraction of pillars and to premature collapse". The main cause of underground fires is the spontaneous combustion of small coal left in the goaves or coal crushed by goaf falls and premature collapses. A few fires have been caused by the spontaneous combustion of accumulations of small coal in old workings. One disastrous fire was caused by the dumping of heated rejections from the manufacture of soft coke on the working faces in a quarry, and there have also been some serious accidental fires. The number of fires has increased considerably in recent years as a result of more extensive depillaring. More fires numerically have been caused by normal collapses, but the more disastrous fires have been caused by premature collapses. It is generally agreed that, even if fires

have been properly isolated, the difficulties of pillar extraction, and the dangers to life and property, are both appreciably increased by the presence of such fires. These difficulties and dangers are increased particularly where seams lie close together or where thick seams are worked in sections.

74. RECOMMENDATIONS OF THE BAGDIGI COURT OF ENQUIRY.— The Court of Enquiry, constituted under section 21 of the Mines Act in connection with the Bagdigi fire of 1935 referred to above, reported as follows:—

"This accident has focussed attention on a problem which exists in most of the coalfields of India, but which is more serious in the Jharia coalfield than in any other. In the Jharia coalfield there are no less than forty separate fires in twenty-two different collieries. These fires demand perpetual vigilance on the part of the management and may constitute a standing menace to the mines in which they exist.

"In most cases up to the present the fires exist in the seam which is being worked, but recently in some mines the extraction of pillars has been commenced in seams which lie below upper seams which are on fire. A special and perhaps unique feature renders the exploitation of the seams extraordinarily difficult. The difficulties did not present themselves forcibly in the earlier days of mining, but in the past few years the extraction of pillars has increased enormously and it is in that operation that the difficulties and problems arise. In many mines working the better class seams, practically the whole of the output is obtained from the extraction of pillars. The extraction of pillars in a thick seam by the method at present practised in the Jharia coalfield has inevitably resulted in the subsidence of the surface and the breaking up of the ground on an extensive scale. Moreover, the method results in the unavoidable loss of a considerable proportion of the coal during the extraction of pillars and the probability of fire breaking out in the coal left in the goaf. It is true that many of the fires that have occurred have been due to unsystematic extraction and reduction of pillars with consequent premature collapses, but the presence of fires which have resulted from such methods has increased the difficulties of extracting the remaining pillars in a seam by systematic methods. When it is mentioned that in some parts of the Jharia coalfield as much as 30 per cent. of the strata in a depth of 300 feet or 400 feet consists of coal in workable seams of great thickness, it will be realised that as one seam after another is extracted, the destruction of the intervening ground is enormous * * * *."

"In considering the problem a difficulty arises in that we have little or no accurate knowledge or experience of the conditions and dangers that may arise in such circumstances. It was mainly for this reason that we deemed it desirable to

obtain the opinions of experts in this enquiry. * * * * There was a wide diversity of opinion as to the precautions that were necessary in mines in which there were fires. It is clear, therefore, that the problems arising from fires in coal mines whether in the same seam or in the working of seams below other seams in which fires exist, call for a full investigation, and this brings us to our first recommendation, *viz.*, that Government should, as soon as possible, appoint a representative Committee to enquire fully into the dangers arising from underground fires in coal mines and to report on the steps that should be taken to combat these dangers. All the expert witnesses examined supported this proposal and one stated that, in his opinion, the necessity for such an enquiry was urgent and overdue. We consider that the scope of the enquiry should include conditions with respect to underground fires in the two major coalfields of Jharia and Raniganj."

75. SPONTANEOUS COMBUSTION—CHEMICAL FACTORS.—Spontaneous combustion is caused by the oxidation of coal and the absorption of oxygen. It is an exothermic reaction, and the rate of oxidation and heat production usually increases as the temperature rises until a point is reached where the rate of oxygen absorption becomes fairly constant. All coals do not absorb oxygen at the same rate, and therefore all coals are not subject to spontaneous heating to the same degree. Anthracite coals, which have a very small volatile content, have also a very small capacity for oxygen and do not therefore fire spontaneously. Coals having a high volatile and high moisture content have a sufficiently large rate of oxidation to give rise to fires without the intervention of any other substance. Between these two limits are coals which fire only under favourable conditions. Oxidation is also initiated or aggravated by the presence of finely distributed pyrites which oxidise more rapidly and with greater evolution of heat. Access of air to the coal is necessary if oxidation is to take place, but good ventilation through the coal will prevent or impede a rise in temperature. Heating is more general if the coal is broken and exposed over a large surface. Coals with a high moisture and low ash content are more liable to spontaneous combustion than those with low moisture and high ash content. The bright parts of coal known as vitrain and clarain show greater liability to oxidise and ignite than does the dull part known as durain, while that soft substance known as fusain, which so readily soils the hands and has the appearance of charcoal, is the most readily ignited constituent of coal.

76. SPONTANEOUS COMBUSTION—PHYSICAL FACTORS.—(*a*) *Thickness of seam.*—The thicker the seam the more difficult complete extraction by ordinary methods becomes, and the greater also is the likely loss of coal in goaves unless the coal is totally or partially replaced by incombustible material. Moreover, tall pillars in a thick seam are more prone to deteriorate and collapse than pillars in thin seams. If the seam is of such a thickness as

to necessitate division into sections, only a very small percentage of the seam can be removed in the first working if stability of the pillars is to be ensured, while extraction of the pillars must at least be accompanied by the loss of the coal in partings between the sections. Any coal lost in a goaf is a potential source of danger from spontaneous heating.

(*b*) *Nature of coal.*—In India the seams of good quality coal are, as a general rule, more friable than those of poorer quality. The friability of a seam may vary very considerably within short distances, and often varies in the same mine. Where tectonic disturbances have taken place, the nature of the seam may have been changed for a considerable distance from the point of disturbance. If a seam has been involved in a shear zone, the coal is likely to have been seriously affected, its power to withstand roof pressure reduced and its liability to spontaneous heating increased. A striking example of this is to be found in the south-eastern part of the Jharia Field at Bhulanbararee, Chasnalla, Sudamdih and Bhowra. Not only does the friability of a seam vary, but the quality of the coal in a seam also varies within a short distance. In the Jharia Field, the upper seams of the Barakar series vary in quality and thickness from east to west. For instance, No. 15 and No. 14 seams are of a superior quality in the east and gradually deteriorate towards the west, while the quality of No. 13 and No. 12 seams is better at the centre of the field than at the eastern and western extremities.

(*c*) *Nature of adjoining strata.*—Certain investigators have found that the thermal conductivity of bituminous coal is about one-tenth that of hard sandstone and one-third that of coal measure shale. From this it follows that a pile of coal covered by shale in a goaf would be more likely to fire than the same pile covered by sandstone, and also that the greater the size of the pile the greater is the liability to spontaneous heating.

(*d*) *Depth.*—The greater the depth of the seam from the surface, the greater is the liability of the coal to crush and form small coal. Moreover, rock temperatures increase as depth increases, and oxidation increases with increasing temperatures.

(*e*) *Effect of vitrain.*—As mentioned above, vitrain is the bright part of coal. It usually contains a much smaller percentage of ash and a larger percentage of volatile matter than the dull coal known as durain. It is very brittle and fractures readily when stressed. As would be expected, the percentage of vitrain in seams of good quality is generally greater than in seams of poor quality, and seams of good quality are therefore more friable and more prone to spontaneous combustion. It is well-known that slack produced from a seam of good quality in the Jharia Field contains a lower ash and higher volatile content than the lump coal from the same seam, and this is due to the higher friability of vitrain and the presence of a greater proportion of vitrain in the small coal and dust than in the lump coal.

77. SPONTANEOUS COMBUSTION—PRACTICAL CONSIDERATIONS.—The size of pillars, the height and width of galleries and general lay-out in development are of the utmost importance. It is during the process of pillar formation, usually known as first working or whole working, that conditions are created which play such an important role in the future working and safety of the mine, in its comparative freedom from fires and collapses, and in the ultimate percentage of recovery of the coal in the seam.

78. LIABILITY TO SPONTANEOUS COMBUSTION.—The coal seams most liable to spontaneous combustion are those with high moisture and high volatile content. Other factors being the same, thicker or better quality seams are more liable than the thinner or poorer quality seams. The seams in the Raniganj series are more liable than those in the Barakar series. Of the Raniganj series, the Kajora, Jambad, Toposi, and Samla seams in the eastern section of the field are, because of their higher moisture content, more liable to fire than such seams in the western part of that field as the Dishergarh, Poniati, Ghusick, and Nega seams. As regards the Barakar series, Nos. 13, 14 and 15 are the most liable to spontaneous combustion, but fires have also occurred in Nos. 10, 11 and 12, particularly where two of these seams have combined to form a very thick seam. The thick seams in the Bokaro and Karanpura Fields are very liable to spontaneous combustion, those in the Giridih Field being comparatively less liable.

79. The Second Subsidence Committee said that "seams vary in their propensities to fire spontaneously, but increasing experience suggests that no seam may be considered safe". Our own opinion is, and our members include the last Chairman of the Second Subsidence Committee, that in the seams of the Barakar series below grade II in quality, which have an extremely low moisture and low volatile and high ash content, the danger of spontaneous combustion is extremely remote. As regards seams in the Raniganj series, with their relatively high moisture and high volatile content, we consider that they are all liable to spontaneous combustion even when below grade II in quality.

80. PERIOD OF INCUBATION.—While some witnesses said that the term "period of incubation" was not understood, one defined incubation as "the period between the first heavy fall of roof in a goaf up to the first evidence of heating". A correct definition would be the period between the creation of conditions favourable to spontaneous combustion and the time when the first signs of heating are observed. As it is impossible to ascertain when conditions favourable to spontaneous combustion are first created, we think that the best practical definition is the period between the first fall or collapse of roof and the first evidence of heating. The period of incubation varies with the ventilation conditions, the nature and quantity of the coal left, and the depth from the surface. It varies from a few weeks to two years, 9 to 18 months being the general average.

81. FIRE AREA.—A fire area includes not only an area actually under fire, but also one which has been sealed off on heating being discovered and has never been reopened since.

82. INFLUENCE OF INTERVENING STRATA IN FIRES AND FIRE CONTROL.—The thickness and nature of the strata between the surface and underground workings have a very important bearing on the relative ease with which fires can be controlled. Fires in workings lying close to the surface are more difficult to control than those at greater depths because the total exclusion of air is almost a physical impossibility as soon as the strata between the seam and the surface have been broken. In the Jharia Field, the coal measure rocks of the Barakar series consist of hard sandstones and shales with a cap of alluvium at the surface. The alluvium is generally very thin and over many areas there is no alluvium at all. A good thickness of alluvium acts as a flexible blanket when the first subsidence takes place as long as that subsidence is not very near to the outcrop of the seam, and this blanket accommodates itself to subsequent settlement without allowing air into the workings. In the Jharia Field, blanketting of the surface to exclude air from a fire necessitates constant and careful attention because every movement of the broken ground produces cracks in the blanketting, while heavy rain generally results in the blanketting material being displaced or washed into the crevices. In the Raniganj series better conditions prevail. Shales predominate over hard sandstones in the strata, and the alluvial cap is generally of considerable thickness. Fires in coal seams of the Raniganj series are, therefore, more easily controlled and quelled than those in seams of the Barakar series. This fact is established by the figures in paragraph 87 and 88 below. Up to the end of 1927, the proportion of coal lost by collapses and fires in the Raniganj and Jharia Fields to coal obtained was as 7·7 : 7·5; in the nine years 1928 to 1936, that proportion was as 12·7 : 16·4.

83. The thickness of the strata between seams is also of major importance when the stage of pillar extraction is reached because, if there is a fire in an upper seam, pillars in a lower seam cannot be extracted safely without stowing unless the strata between the seams is of such thickness as to prevent gases from the fire descending through broken strata to the lower seam. In the Jharia Field, No. 15 seam is from 18 to 30 feet thick, strata to No. 14A seam are from 10 to 30 feet, No. 14A seam is 7 to 15 feet thick, strata to No. 14 seam are 60 to 100 feet, No. 14 seam is 17 to 28 feet thick, strata to No. 13 seam are 6 to 200 feet, and No. 13 seam is from 11 to 20 feet in thickness. In one part of this coalfield, there is no less than 63 feet of coal in 145 feet of strata. A fire in one seam would render the extraction of pillars in the lower seam unsafe unless the strata between the seams were kept intact by systematic stowing during depillaring. Somewhat similar conditions prevail in part of the Raniganj Field where the Koithi seam is separated from the Poniati seam by about 120 feet of strata. Since the introduction of Temporary Regulation No. 10 in May

1936, the extraction of pillars under fire areas has been prohibited in a number of mines, and large quantities of coal standing in pillars have been locked up until sand-stowing can be arranged for.

84. Losses from collapses and fires.—Both in the Raniganj and Jharia Fields, large quantities of coal have been lost by premature collapses and fires which have started in the collapsed areas. Large quantities of coal have also been lost because suitable barriers between adjoining mines have not been maintained and a fire from one mine has been able to traverse several adjoining mines. Prior to the introduction of Regulation 76 in 1926, barriers between mines were not required by law, and in many mines barriers were either not left or, where left, were frequently so thin as to be of no practical value in confining a fire to the mine in which it began. These conditions still obtain in many mines in which large quantities of coal are standing in pillars and, unless artificial barriers are made with incombustible material and pillars are extracted in conjunction with stowing, heavy losses are certain to occur. Again, in many mines in these coalfields, the galleries have been made to the full height of the seam, even where the seam is over 20 feet in thickness, and the percentage of coal left in the pillars is too small to ensure stability during pillar extraction. Depillaring under such conditions will be followed by over-riding and collapses, and probably by fires.

85. In the south-eastern portion of the Jharia Field, there are two seams which attain a maximum thickness of 60 and 85 feet respectively, and are steeply inclined; the coal moreover is soft and strongly cleaved. The Second Subsidence Committee said that " very little evidence of the effects of depillaring steep seams is available ", and added in another place that there had been " very little opportunities of studying the effects of high inclinations on depillaring owing to the lack of exploitation of the highly inclined areas as a result of the industrial depression ". Fires following premature collapses in the old working near the outcrops of these seams have already accounted for a loss of about $6\frac{1}{2}$ million tons of very good coal. In recent workings in these seams, the percentage of first extraction is from 12 to 25 only and, unless stowing is adopted, pillar extraction will result in a loss of more than 50 per cent. of the total seams which have been estimated to contain over 45 million tons.

86. Large quantities of coal have also been lost because, in laying out workings, no provision was made to confine outbreaks of fire to comparatively small areas by leaving internal barriers of coal at reasonable intervals. These losses generally took place in parts of mines where the pillars were formed years ago, and in which the galleries were of such large dimensions as to make the confining of fires to small areas extremely difficult or even impossible.

87. Statistics of losses by Collapses and Fires.—In Mr. N. Barraclough's paper on " Coal lost by Fires and Collapses in

Indian Coal Mines" (Records of the Geological Survey of India, Volume LXII, Part 3) the quantities of coal lost in the Jharia and Raniganj Fields were given as follows:—

Field.	Grade of coal.	Total quantity of coal entirely lost by fires and collapses.	Quantity of coal locked-up in fire areas, but considered recoverable.	Quantity of coal obtained from the Field.	Quantity of coal entirely lost expressed as a percentage of coal obtained.
		Tons.	Tons.	Tons.	
Raniganj . .	Selected and 1st grade .	9,062,960	3,907,800	120,500,000	7·52
	2nd and inferior grade .	4,243,000	370,000	51,500,000	8·24
	TOTAL .	13,305,960	4,277,800	172,000,000	7·73
Jharia . .	Selected and 1st grade .	15,612,832	2,310,000	136,000,000	11·48
	2nd and inferior grade .	100,000	*Nil*	73,000,000	0·14
	TOTAL .	15,712,832	2,310,000	209,000,000	7·52

These figures included all known avoidable losses of coal from the inception of mining in each coalfield up to the end of 1927. The figures did not cover unavoidable losses (*viz.*, losses normal to the method of working such as coal left in barriers, coal lost in stooks during pillar extraction, etc.), nor did they include roof or floor coal left in depillared areas.

88. From 1928 to the end of 1936, the avoidable losses in these two coalfields have been carefully estimated for us by Mr. Barraclough as follows:—

Field.	Grade of coal.	Total quantity of coal entirely lost by fires and collapses.	Quantity of coal locked up in fire areas, but considered recoverable.	Quantity of coal obtained from the Field between 1928 and end of 1936.	Quantity of coal entirely lost expressed as a percentage of coal obtained.
		Tons.	Tons.	Tons.	
Raniganj . .	Selected and 1st grade .	6,062,100	5,329,300	56,642,000	10·70
	2nd and inferior grade .	1,750,000	882,500	4,489,000	38·98
	TOTAL .	7,812,100	6,211,800	61,131,000	12·78
Jharia . .	Selected and 1st grade .	13,578,600	3,937,800	65,584,000	20·70
	2nd and inferior grade .	478,800	1,000,000	20,033,000	2·43
	TOTAL .	14,061,400	4,937,800	85,617,000	16·42

These two tables show that the percentage losses of selected and grade I coal in the Raniganj and Jharia Fields have increased, since the end of the year 1927, from 7·52 to 10·70, and from

11·48 to 20·70 respectively. This increase in the percentage loss in the Jharia Field was predicted on numerous occasions by various authorities. It was confidently expected by those well acquainted with the local conditions because the percentage of coal obtained by depillaring was quite certain to increase as the life of the coalfield advanced, and because increasing pillar extraction was certain to be accompanied by increased premature collapses and fires.

89. The loss of 13·57 million tons of selected and grade I coal in the Jharia Field from 1928 to 1936 as compared with 15·61 million tons between 1894 and 1927, does not represent the full gravity of the situation. Before the end of 1927 a large proportion of the losses, amounting to about $6\frac{1}{2}$ million tons of good coal, occurred in the very thick and very steeply inclined seams of one small section of the coalfield lying between Chasnalla and Bhowra, where the workings were comparatively small in area and did not extend far from the outcrops. Since the end of 1927, most of the fires have occurred in seams of more normal inclination and thickness, and have therefore covered more extensive areas. Under these extensive fire areas, there are other valuable seams from which pillars cannot be extracted except in conjunction with stowing.

90. The figures given in the above tables may be analysed from another aspect as well. The percentage of the output of good quality coal obtained from the Jharia Field by pillar extraction has been ascertained to be over 50 per cent. in 1935. If reasonable assumptions are made (i) that the percentage of good coal obtained between 1928 and 1936 was 50 per cent. of the output, and (ii) that the pillars extracted during that period of 9 years were almost all formed prior to 1928, the following conclusions are justified:—

	Million tons.
(*a*) Total output of good quality coal 1928 to 1936 .	65·6
(*b*) Output of good quality coal obtained from pillars was $\frac{65{\cdot}6 \times 50}{100} =$	32·8
(*c*) Allowing 3 per cent. for free supply to miners and theft, coal raised was $\frac{32{\cdot}8 \times 100}{97} =$.	33·8
(*d*) Assuming that the average losses during pillar extraction (losses in stooks, parts of pillars, etc.) were 15 per cent. of the coal in pillars, the quantity of coal in the pillars extracted was $\frac{33{\cdot}8 \times 100}{85} =$	39·8
(*e*) Assuming that the percentage of coal in the pillars left in internal barriers round depillaring areas was the low figure of 20 per cent., the quantity of coal in pillars exploited to obtain 32·8 million tons was $\frac{39{\cdot}8 \times 100}{80} =$	49·75

(*f*) Adding to 49·75 million tons, the 13·5 million tons lost by major fires and collapses, the total coal in pillars exploited was . . 63·25

(*g*) The percentage of coal in pillars lost or left was $\frac{(63{\cdot}25-32{\cdot}8)\times 100}{63{\cdot}25}$ = ... 48·1 per cent.

91. According to Mr. Barraclough's paper on "The Coal Resources of the Jharia Coalfield" (Records of the Geological Survey of India, Vol. LXII, Part 3) the amount of good quality coal standing in pillars in the Jharia Field at the end of 1927 was 131 million tons. Of this quantity, about 63 million tons have been extracted or lost, and 68 million tons remain. The extraction of this 68 million tons must, unless stowing is enforced, be accompanied by dangers and losses at least equal to those which have occurred during the extraction of the 63 million tons. The losses of good quality coal in the Raniganj Field during the 9 years ending 1936 were only 44·6 per cent. of the Jharia losses, while the percentage of loss of such coal in the Raniganj Field increased by 3·18 per cent. as compared with 8·86 per cent. in Jharia. The percentage loss of inferior quality coal increased, however, by 30·74 in Raniganj as compared with 2·29 only in Jharia. This very large percentage increase in Raniganj was due to collapses and fires in old workings, and abandoned mines, against comparatively small outputs. The Dishergarh and Poniati seams, both of selected grade quality, and generally less than 16 feet in thickness, provide respectively about 25 and 26 per cent. of the total output of the Raniganj Field. The output from the Jambad, Bowla or Lower Kajora seam is about half a million tons annually. This seam varies in thickness up to 40 feet and the whole of the output is being obtained from galleries. The seam is known to be very liable to spontaneous combustion and, when the depillaring stage is reached in the near future, losses by fires will occur unless stowing is enforced.

92. Account of actual collapses and fires.—Short accounts of 28 cases of major fires and collapses which have occurred in the Raniganj and Jharia Fields will be found in Appendix A to our Report. These accounts should help those who do not know the mining conditions well to appreciate better how collapses and fires prejudice not only the exploitation of coal resources, but also the safety of those working in the mines.

93. Inundations of water.—According to the Second Subsidence Committee: "The effect of water on subsidence is a considerable one. Not only are faults, joints and fractures in the superincumbent strata near the surface generally lubricated by water which results in more subsidence during the monsoon season, but the water as such has a considerable deteriorating action on the strength of the rocks themselves." Where subsidences or breaks to the surface have occurred, the pumping of water out of mines during the monsoons is almost always a difficult and expensive problem.

94. ACCIDENTS FROM INUNDATIONS.—There have been many accidents through irruptions of water, some of the most serious being:—

Colliery.	Date.	Lives lost.	Sources of water.
Murulidih . .	1910	6	Underground.
Phularitand . .	1912	23	Surface water.
Bhatdih . .	1913	8	
Jamadoba . .	1913	7	
Jotejanaki . .	1913	13	
Bhaskajuri . .	1928	7	Underground.
Loyabad . .	1936	11	

There have also been other dangerous cases of flooding from surface or underground water, the Bagdigi disaster of 1935 being an instance where the bursting of a surface embankment let water into a fire area and caused an explosion. Nineteen lives were lost and the whole colliery has been on fire since. No less than 51 orders were issued by the Chief Inspector of Mines in 1936 under section 19 (2) of the Indian Mines Act restricting or prohibiting workings in order to guard against possible dangers from irruptions or inundations of water.

95. CAUSES OF INUNDATIONS.—The main causes of such irruptions of water are:—

(i) Openings into mines too close to rivers or *jores*.

(ii) Unusually high floods in rivers or *jores*.

(iii) Inadequate barriers or insufficient maintenance of barriers.

(iv) Inaccurate plans leading to the penetration of galleries into old workings under water.

(v) Subsidence of river beds or bursting of surface embankments.

96. GENERATION OF GASES BY INUNDATION.—The cause of the Bagdigi explosion is a subject of controversy, but *Question 26* in our general questionnaire was framed on the assumption that the irruption of water into a fire area had in this instance generated gases and led to an explosion of an inflammable mixture of gas and air penetrating the mine workings. Of the 46 technical witnesses who dealt with this question, 33 admitted the danger or thought that, in certain circumstances, the danger might arise; 6 disagreed with the suggestion that dangerous inflammable gases would be generated in the circumstances, while 7 stated that it was a matter of opinion whether inflammable gases would be generated in the manner suggested. The assessors on the Court of Enquiry under section 21 of the Act advanced the theory that inflammable gases may have been generated when the water from the surface entered the workings in Nos. 15 and 14A seams in which there was incandescent fire, and that the gases so generated

were swept into the workings of No. 14 seam where they were ignited by the fire itself, the explosion spreading to the workings in the lower seams. Water gas consists of varying percentages of hydrogen, carbon-monoxide and carbon-dioxide, and is generated in the following manner. Coke is first raised to incandescence by forced draught, and superheated steam is then blown through it until the temperature of the coke falls to a predetermined point. The coke is again raised to incandescence by forced draught before steam is readmitted. Continued high temperatures of the steam and coke are essential to the process and, if the temperatures fall, the amount of carbon-dioxide produced increases rendering the resultant gases progressively less inflammable. It is conceivable that a small quantity of water playing on a very active fire underground would result in the generation of water gas, but it is doubtful whether such gas would be generated if a large quantity of water reached the fire. We are of opinion that the generation of water gas in the manner suggested is largely a hypothesis and that a combination of conditions favourable to the generation of such gas would be extremely rare in actual practice. The fact remains, however, that an inundation of water in conjunction with an existing fire area was responsible for this particular explosion. It may be added that water entering a fire area might itself destroy stoppings surrounding an area, or the stoppings might be destroyed by steam generated within the fire area. In either event, danger in the working parts of the mine would certainly be caused.

•97. Fatal casualties from explosions.—During the 30 years 1906 to 1935, the total number of persons killed in Indian coal mines by explosions or ignitions of fire-damp and coal-dust was 384, while the total number of persons killed by all causes during the same period was 5,444. The percentage of persons killed by explosions and ignitions to the total number killed was therefore 7.

98. Although explosions in mines are spectacular and attract public attention, they do not normally account for such a high average death rate as accidents from falls of roof, falls of side and from haulage, which occur frequently, but seldom involve more than one or two persons at a time, and do not therefore provide " news ". Nevertheless, the danger from explosions cannot be regarded lightly nor discounted, while failure to take adequate precautions would result in an increasing number of grave disasters and a higher death rate. As underground workings go to greater depths, the dangers from fire-damp and coal-dust increase; more fire-damp is likely to be emitted by gassy seams and more by seams which at shallower depths were considered non-gassy. Again, at greater depths mines usually become drier and more coal-dust is manufactured owing to the more extensive use of haulages and machinery.

99. Fire-damp.—Fire-damp is known also as marsh gas or methane, its chemical formula being CH_4. It is liberated by the decomposition of organic vegetable matter and, as coal was formed in the remote ages by such decomposition, this gas is pent

up both in coal and its associated strata, and is released when the coal and the strata are disturbed. Most coal seams and their associated strata contain fire-damp; some seams contain more than others, and some very little or none at all. In some cases the volume of fire-damp liberated from broken coal is many times greater than the volume of the coal itself, and may be as much as 100 times as great. How the gas exists in the coal is a matter of conjecture; it may be imprisoned in the pores of the coal under high pressure, or it may be held in the coal in a state of occulsion, either condensed in the molecular spaces or upon the surfaces of the cellular spaces of the coal. At one mine in England, the quantity of fire-damp given off was 2,000 cubic feet per ton of coal raised, and at certain mines in British Columbia the discharge was as much as 5,000 to 8,000 cubic feet per ton of production.

100. In India, the majority of seams of good quality coal give off fire-damp, the Dishergarh and Sanctoria seams in the Raniganj series usually giving off fairly large quantities, while the Begunia, Laikdih, Ramnagar, Nos. 17 and 18 and the Kargali seams in the Barakar series usually give off appreciable quantities. The very thick Kargali seam at Jarangdih Colliery in the Bokaro Field produced an exceptionally large quantity of fire-damp and the mine was considered to be one of the most gassy in the world. In the seams below No. 10 in the Jharia Field, and in the mines producing inferior grades of coal west of the Barakar River in the Raniganj Field, no fire-damp has yet been detected.

101. The quantity of this gas usually increases with depth, and the fact that it has not been detected in shallow workings is no indication that it will not be found in deeper workings of the same seam. Fire-damp is light as compared with air and is therefore liable to collect in high places where it is difficult to test for with a safety lamp. For the same reason, when the rocks above a seam are pervious, the likelihood of finding gas is diminished and it will be small in quantity if present. When goafing is at depths where surface breaks do not occur, fire-damp accumulates in the roof cavity over the local fall and cannot be expelled except by further falls when it is apt to be driven out in dangerous quantities. When breaks occur to the surface, the gas escapes through the cracks in the strata.

102. Fire-damp is not poisonous, but, if breathed in an undiluted state, produces death by suffocation because of the absence of free oxygen. Mixed with air it becomes inflammable when $2\frac{1}{2}$ per cent. is present, and explosive when the mixture contains over 5 per cent. As the percentage of the gas increases, the mixture becomes more and more explosive until the maximum explosive point is reached, when the percentage of gas reaches 9·4. As the percentage increases further, the mixture becomes less and less explosive and, when about 15 per cent. of gas is present, the higher explosive limit is reached and self-propagation is no longer possible. If the mixture contains over 15 per cent., it is no longer explosive, but a mixture containing up to 33 per cent. of gas will continue to burn in the presence of an external source of heat or flame.

103. The presence of fire-damp in percentages less than the lower explosive limit (5 per cent.) increases the inflammability of coal-dust in proportion to the percentage of gas present. American investigators have shown experimentally that, for every 1 per cent. of fire-damp present, from 3 to 8 per cent. more stone-dust must be added to coal-dust than it is necessary to add to that dust to prevent ignition or propagation when fire-damp is entirely absent, and the United States Bureau of Mines recommends that, where fire-damp is present in the ventilating current, the amount of incombustible material should be raised to 10 per cent. for each 1 per cent. of fire-damp present.

104. A fire-damp and air mixture may be ignited in a mine in numerous ways, the most common being:—

(*a*) By flame.

(*b*) By a heated surface such as (i) safety lamp gauzes heated by continued burning of fire-damp inside them, (ii) wires heated electrically and accidentally exposed to the atmosphere in the mine, (iii) frictional sparks caused by blows from metal tools on rock, (iv) masses of rock striking each other, (v) incandescent coal, resulting from spontaneous combustion, and (vi) metal, wood or stone surfaces raised in temperature by excessive frictional heat.

(*c*) By electric sparks, *e.g.*, those produced by mining machinery, by electrical signalling or shot-firing apparatus, and frictionally by rubbing surfaces.

(*d*) By explosives.

105. The modern oil safety lamp, when undamaged, is quite safe to use underground if it is properly handled. The danger arises when gas is ignited in the lamp and is allowed to continue burning. This danger is provided for in the bye-laws made under the Indian Mines Act. Under such circumstances, the lamp must be handled with care; it must be lowered gently, and either carried steadily into the fresh air, or the flame smothered or extinguished by water. The labourers employed in Indian mines are almost all ignorant and illiterate. The proportion of settled labour is small, and the miners are mostly agriculturists who work for short periods at a time in between their cultivation. They look on the safety lamp as a means of illumination only, and cases of lamps being wilfully damaged or forcibly opened are not uncommon. Electric safety lamps, though more expensive, are therefore preferable in Indian mines. It is less easy to take underground undetected an incorrectly-assembled electric lamp and, in any event, an incorrectly-assembled electric lamp is not so likely to be dangerous in use as a flame safety lamp in the same condition. It should be remembered of course that a certain number of flame safety lamps will always be necessary for purposes of inspection and testing.

106. The ignition of fire-damp by friction between certain kinds of rocks is comparatively easy under laboratory conditions. Two explosions occurred at mines in Alberta, Canada, when none was underground. Electricity was not used and there were no fires in the mines. The seams were thick and there were large open spaces. After the explosions it was found that large falls of roof had taken place. The explosion at the Minnie Pit (Staffordshire) is thought to have been caused by sparks from falling rocks. The ignition of fire-damp by sparks produced by coal-cutting machine picks is now a recognised fact, and it is believed that a small blower of gas in a mine in India was ignited by a spark produced by a miner's pick striking rock. Instances of ignition of fire-damp by electrical apparatus, by goaf fires, by defective safety lamps, by safety lamps broken by falls of roof or side, by heating of wood or metal as a result of excessive friction, and by explosives are too numerous to mention.

107. Other gases.—Explosions of fire-damp in a mine produce after-damp which is a mixture of gases including black-damp (CO_2) and white-damp (CO). Black-damp dims or extinguishes a light, and is dangerous in large percentages. White-damp which has no taste, colour or smell, is very dangerous even if less than one per cent. present. Stink-damp (H_2S) has a peculiar smell and is known also as " gob-stink " because it is a forerunner of fire and indicates that spontaneous combustion has started.

108. Coal-dust.—As a result of experiments conducted in many countries including India, the explosive property of coal-dust, when raised in a cloud in air, has been established beyond question, and it is now regarded as highly dangerous by the whole mining profession. Coal-dust absorbs or occludes gases like charcoal. It occludes oxygen from the air and each particle of dust thus becomes a minature explosive ready to be fired by the detonating action of even a slight explosion of fire-damp. Investigations in Great Britain, America and India have shown that there is a broad general relationship between the volatile and ash content of a seam and the inflammability of its dust, the dust of coals of high volatile and low ash content being the most inflammable. In all extensive mine explosions, coal-dust has been responsible for the propagation of the explosion over large areas in which no fire-damp was present. To it may also be attributed in a large degree the development of destructive violence and the production of poisonous gases and fires. As fire-damp is seldom present in a mine in very large amounts, explosions due to it alone are usually limited in extent. Though, in most extensive explosions, fire-damp plays an important part, it is merely as the medium initiating the coal-dust explosion. It is for this reason that local accumulations of fire-damp are so dangerous because the ignition of a small quantity of it may raise a cloud of coal-dust which is in turn ignited with the result that the explosion is accentuated and carried through the whole mine.

109. Coal-dust is unavoidably produced in mines in a variety of ways. The extent to which it is produced depends largely on the

friability and dryness of the coal, the method of working (*i.e.*, whether coal-cutting machines are being used), the extent to which explosives are used, and the maintenance of properly-laid and clean haulage and tramming roads.

110. The fineness of coal-dust is of paramount importance as it determines (*a*) the ease with which a dust cloud can be raised, (*b*) the rate of reaction between the oxygen in the air and the combustible particles, and (*c*) the rate at which heat can be absorbed by the particles. Coal-dust particles coarser than 15 mesh (I. M. M. standard) have little effect in influencing the development of an explosion.

111. A very small concentration of coal-dust is sufficient to render an atmosphere inflammable. Explosions have been obtained with as little as 0·09 of an ounce per cubic foot of air space. A concentration of from 0·18 to 0·5 ounce of fine coal-dust per cubic foot of air space is sufficient to produce an explosion of maximum intensity.

112. Coal-dust has been the means of strengthening and lengthening many local explosions of fire-damp over extensive areas in mines. While it is generally admitted that the risk of coal-dust explosions is greater in seams which give off fire-damp than in those which are not gassy, the danger from coal-dust in all mines cannot be neglected and should be guarded against. Many extensive explosions have occurred where the igniting medium has quite definitely not been fire-damp. In India two such explosions (Parbelia and Joktiabad) have occurred, the igniting medium in each case being a blown-out shot, and in other countries the use of explosives, generally the incorrect or improper use, has resulted in many disastrous coal-dust explosions.

113. Another danger is from fires caused either by spontaneous combustion or accidental ignition. Such fires produce inflammable gases by distillation of coal which are likely to be ignited by the fire. The presence of coal-dust greatly increases and amplifies the danger. The Bagdigi explosion of 1935 is said to have been caused in this way.

114. PREVENTIVE MEASURES.—The risk of coal-dust explosions may be reduced by:—

(*a*) Preventing the accumulations of coal-dust by (i) frequent cleaning of roads, (ii) providing dust-tight tubs, (iii) maintaining good haulage and tramming roads, and (iv) spraying loaded tubs with water at loading points.

(*b*) Avoiding as much as possible the use of explosives so as to prevent the initiating explosion, or proper treatment with water or stone-dust before all shot-firing.

(*c*) Watering or stone-dusting roads and working places to keep coal-dust down.

(*d*) Setting out wet or dusted zones to arrest explosions.

(*e*) Regular, systematic and accurate testing for fire-damp followed by proper measures for its dispersal when discovered and before it becomes dangerous.

(*f*) Eliminating, as far as possible, accidental means of ignition, *e.g.*, by defective safety lamps.

115. The whole subject has been exhaustively dealt with in three reports by a Committee appointed by the Government of India to investigate the dangers arising from coal-dust in Indian mines. Various regulations have already been framed to guard against these dangers, and we will suggest various additions and alterations of the Regulations in a later chapter.

CHAPTER VI.

The Problem of Conservation with particular reference to Reserves of Good Quality Coal.

116. MEANING OF CONSERVATION.—Speaking generally, conservation is the preservation of anything that is being wastefully used or unnecessarily destroyed. So far as the subject of our enquiry is concerned, we understand that conservation should make available safely the maximum quantity of extractable coal of commercial or industrial value. A policy of coal conservation may cover utilisation as well, but such conservation cannot come until research has enabled far more to be known about the best way in which particular kinds or qualities of coal should be used. We think therefore that, at this stage, State conservation over use should be restricted to users whom Government already controls, *e.g.*, the State Railways. State conservation as regards availability of a national asset is justified if serious avoidable waste is going on apart from any shortage of resources, and it becomes imperative if such waste is accompanied by a known shortage of that asset sufficient to arouse serious apprehension. We have already established fully that serious avoidable waste of coal has been going on for many years, is now going on, and will go on increasingly unless it is checked and prevented by effectual State control. Such control is a frontal attack on actual waste, whereas conservation is more like a general enveloping movement aiming at the fullest possible recovery of the available resources including the waste prevented by control. Conservation and safety are connected together as closely as two sides of the same coin. Conservation will be promoted if future safety measures protect workings as well as workers, and if such measures extend not only to conditions in which danger is present, but also to conditions in which danger is likely to be produced. Conversely, conservation must increase safety by eliminating many of the dangers against which it is now necessary to provide measures of protection. For example, if the legal enforcement of universal stowing were practicable, safety would be almost completely assured. If, however, stowing were not compulsory, or were only compulsory within certain limits and under certain conditions, legal provision for the safety of life and property must continue to be made.

117. RESERVES OF COAL.—What we are concerned with in this chapter is whether India's reserves of coal are really limited and, if so, to what extent. It may be conceded at once that the reserves of coal of inferior quality (grade II and grade III of the Grading Board classifications) are practically unlimited. As regards coal of good quality (selected grade and grade I) avoidable waste was established in 1920, but this waste was not considered serious enough to justify Government interference and control in the interests of conservation because the available figures of reserves were admittedly largely guess-work, while the leading Indian

authorities did not agree even as regards those figures. Since then, a comprehensive survey of the Indian coalfields has been made by the Geological Survey Department between 1925 and 1929, and the Government of India has stated (in letter No. M955 of the 17th June 1936) that this survey has " removed all reasonable doubt regarding the importance of conserving the coal assets of the country, particularly in the higher grades ". More recently, at the annual meeting of the Indian Mining Federation held in Calcutta on the 22nd March 1937, the President is reported to have said, in dealing with the question of conservation of coal, " that there was no manner of doubt in regard to its urgency and necessity. The recent collapses and fires have so accentuated the position that arguments in favour of prevention of waste of this irreplaceable national asset can hardly be over-emphasised ".

118. Reserves in other countries.—The latest estimate we have seen of the reserves in the United Kingdom is contained in the Report of the 1925 Royal Commission. The reserves up to the 31st December 1925, calculated up to a depth of 4,000 feet in seams of 1 foot thick and upwards, are there estimated at 194,355 million tons which, assuming that the rate of output remained fairly constant, " will last for between four and five centuries ". In the United States of America, the reserves up to 3,000 feet are estimated at the colossal figure of nearly 3 billion metric tons. In Germany, coal deposits up to 1,000 metres are expected to last about 600 years at the 1935 production rate, while in France the reserves are said to be 20,000 million tons or sufficient for 400 years on an average annual extraction of 50 million tons. Yet in all these countries, as we shall show in Chapter VIII, various measures have been taken by the State to conserve resources and to check waste in production, distribution and consumption. It may be added that, according to Tables 17 and 18 of " Indian Coal Statistics, 1935 ", the Indian output of 22 million tons in 1934 compares as follows with the principal coal-producing countries of the world:—United States of America 372 millions, the United Kingdom 224 millions, Germany 123 millions, Russia 92 millions, France 47 millions, Japan 32 millions, China 28 millions and Belgium 26 millions.

119. Reserve of Good Quality Coal in India.—In considering India's coal resources, we have followed the figures of Dr. Cyril S. Fox, who himself surveyed the coalfields of Bihar and elsewhere, and supervised Mr. E. R. Gee's survey of the Raniganj Field in Bengal. His figures of reserves of workable coal are given at pages 342 to 345 of Volume LIX of the " Memoirs of the Geological Survey of India ". His calculations were based on " the rough and ready rule that a one-foot seam yields a million tons per square mile ", and he made no allowance except for the coal extracted from small or well-developed coalfields. This should be borne in mind because, as we have shown in Chapter V, there were large losses before 1932 from avoidable waste and from collapses and fires; these losses would justify some deduction from Dr. Fox's figures of the Raniganj and Jharia reserves. Dr. Fox's figures

of reserves of workable coal of good quality (*i.e.*, selected grade and grade I of the Grading Board classifications) are from seams up to a depth of 2,000 feet and averaging 16 per cent. ash on a moisture-free basis.

120. Dr. Fox estimated that, at the end of 1932, the total coal reserves were 60,000 million tons of which only 20,000 million tons were workable. Of the latter figure, only 5,000 million tons was of good quality made up as follows:—

	Million tons.
Giridih and Jainti	40
Raniganj	1,800
Jharia	1,250
Bokaro	800
Karanpura (North and South)	750
Hutar, Johilla, Burhar	50
Kurasia, Jhilmili, etc.	30
Talchir to Korba	200
Mohpani, Kanhan-Pench	30
Ballarpur-Singareni	50
Total	5,000

Of this quantity, 3,500 million tons were within a depth of 1,000 feet, and the rest between 1,000 and 2,000 feet.

121. The above figures are up to the end of 1932. We have brought them up to the end of 1936 taking into account production and probable losses between 1933 and 1936. In the Raniganj Field, the output of good quality coal during that period was about 26 million tons, and the probable loss (assuming 50 per cent. output from pillars) due to waste in working, collapses and fires, was about 40 per cent. of the production. Hence we arrive at 36·4 million tons as the total to be deducted from the 1932 reserves. In the Jharia Field, the output of good quality coal was about 27 million tons, and the probable loss (again assuming a 50 per cent. output from pillars) due to waste in working, collapses and fires was about 50 per cent. of the production. This gives a total of 40·5 million tons to be deducted from the 1932 reserves. In the other comparatively unimportant fields, the actual production may be deducted with only a comparatively small allowance for loss. According to the figures supplied to us at Giridih, that Field now contains about 15 million tons in the State collieries, and about 5 million tons more may be allowed in the other areas. The Jainti Field contains less than 2 million tons of good quality coal according to the recent estimate in Mr. P. K. Chatterjee's paper on "The Geology and Coal Resources of the Jainti Coalfield" in "Volume VIII of the Quarterly Journal of the Geological, Mining and Metallurgical Society of India".

122. ESTIMATED RESERVES AT THE END OF 1936.—Applying the above calculations to Dr. Fox's 1932 figures, we arrive at the following reserves of good quality coal at the end of 1936:—

	Million tons.
Giridih and Jainti	22
Raniganj	1,763·6
Jharia	1,209·5
Bokaro	795
Karanpura (North and South)	749
Hutar, Johilla, Burhar	50
Kurasia, Jhilmili, etc.	27
Talchir to Korba	198
Mohpani, Kanhan, Pench	30
Ballarpur-Singareni	45
Total	4,889·1

123. COKING COAL OF GOOD QUALITY.—So far as is known at present, coal of coking quality suitable for metallurgical and foundry purposes is found only in the Jharia, Raniganj, Giridih and Bokaro Fields. According to Dr. Fox, coking coal is of a character which, when subjected to destructive distillation, yields a hard coke of low ash (under 21 per cent.) content, fine porous texture, a silvery appearance, and strength (hardness and toughness) to resist crushing. Dr. Fox's figures of reserves of good coking coal at the end of 1932 are:—

	Million tons.		
	Total.	Up to 1,000 feet.	From 1,000 to 2,000 feet.
Giridih	30	30	...
Raniganj	250	82	168
Jharia	900	737	163
Bokaro	320	320	....
	1,500	1,169	331

Giridih: The Lower Karharbari seam at Giridih gives the best hard coke in India and a part of it is low in phosphorus. The present reserves are about 20 million tons as already stated.

Raniganj: The better coking coals in this Field come from the Ramnagar and Laikdih seams; the Begunia, Sanctoria and Dishergarh seams in the western part of the Field are also of coking quality, but the coke is not so strong and is generally considered unsuitable for metallurgical purposes except perhaps when mixed with good coking coals. The production of coking coal from this Field between 1933 and 1936 is estimated at 14 million tons and the associated loss at 40 per cent. of the output. Hence, 19·6 million tons have been used up since 1932.

Jharia: A very large proportion of the coal in Jharia is of coking quality. All the seams from No. 10 upwards coke, the best being Nos. 14, 14A, 15 and 17. The output of good quality coking coal from 1933 to 1936 amounted to 27 million tons. Adding associated loss at 50 per cent. of the output, we get 40·5 million tons to be deducted from the 1932 reserves.

Bokaro: The Kargali seam is all of coking quality though sections of it are higher in ash than Jharia coals. From 1933 to 1936, a little over 5 million tons were extracted from the quarries, bringing the reserves down to 315 million tons.

Jainti: Mr. Chatterjee's estimate of good quality coking coal (low in phosphorus) in the Jainti Field is 1·3 million tons.

124. COKING COAL RESERVES AT THE END OF 1936.—Making the above deductions, we may estimate that the reserves of good quality coking coal at the end of 1936 were:—

	Million tons.
Giridih	20
Raniganj	230·4
Jharia	859·5
Bokaro	315
Jainti	1·3
Total	1,426·2

125. LIFE OF THE ABOVE RESERVES—ALL GOOD QUALITY COAL.—The average production of good quality coal from all the fields in India may be taken at 20 million tons per annum. Of the present reserves of 1,764 million tons in Raniganj, about 133 million tons are standing in pillars; in Jharia the reserves are 1,209 million tons of which 163 million tons are standing in pillars. The quantities in pillars in Giridih, Bokaro and Karanpura are 10·5, 2·5 and 1·4 million tons respectively.

126. At the present rate of production, and with the present methods of extraction giving an ultimate recovery of 50 per cent., the reserves up to the end of 1936 will last:—

$$4{,}889 \times \frac{50}{100} \times \frac{1}{20} = 122 \text{ years.}$$

127. COKING COAL OF GOOD QUALITY.—The reserves of coking coal in the Bengal and Bihar Fields amount to 1,426 million tons. Assuming an average ultimate extraction of 50 per cent. because most of the reserves are in the Jharia Field, and taking present annual production at 11·5 million tons of which about 7·5 million tons comes from Jharia, the life of the coking coal reserves at the end of 1936 works out at:—

$$1{,}426 \times \frac{50}{100} \times \frac{2}{23} = 62 \text{ years.}$$

This figure corresponds very closely with Mr. Barraclough's estimate of 68·6 years in 1927. (See "The Coal Resources of the Jharia Coalfield" in "Volume LXII, Part 3, of the Records of the

Geological Survey of India ".) Mr. Barraclough then pointed out that, as the losses would be greater as time went on, his figure was an optimistic one.

128. NON-COKING COAL OF GOOD QUALITY.—The recoverable reserves at the end of 1936 were 4,889 - 1,426 = 3,463 million tons. The annual output of good quality coal (excluding coking coal used for purely metallurgical purposes and amounting to about 2·5 million tons) is about 17·5 million tons. If the use of coking coal were restricted to metallurgical purposes, and the remaining coking coal now used for other purposes had to be replaced by non-coking coal of good quality, the reserves of non-coking coal of good quality would, on a basis of 50 per cent. recovery, last for:—

$$3{,}463 \times \frac{50}{100} \times \frac{2}{35} = 99 \text{ years.}$$

It follows therefore that the reservation of coking coal for metallurgical purposes, accompanied by a prohibition against coking coal being used for other purposes as it is at present, would put the reserves of non-coking coal of good quality into almost as precarious a position as the reserves of coking coal of the same quality.

129. RESERVES IN THE JHARIA FIELD.—In view of the special conditions in this Field, such as the thickness of the seams, the thinness of the partings between seams, and the difficulties and dangers which will be encountered at depths of more than 1,000 feet, it is improbable that the percentage recovered out of the reserves up to 2,000 feet will be as much as 50 per cent. Allowing this percentage of ultimate recovery, however, and the average annual production being about 7·5 million tons, all of good quality coking coal, the life of the reserves of good quality coal will be

$$1{,}209 \times \frac{50}{100} \times \frac{2}{15} = 81 \text{ years.}$$

and the life of the reserves of good quality coking coal will be

$$859{\cdot}5 \times \frac{50}{100} \times \frac{2}{15} = 57 \text{ years.}$$

130. SIGNIFICANCE OF FIGURES OF RESERVES.—No one will deny that the above figures, based as they are on the assumption that production will not increase, are calculated to arouse serious apprehension as to the future of India's position as a coal-producing country and to justify strong measures of conservation in the national interest. Table XI (slightly modified from Dr. Fox's figures) attached to our Report shows the chief deposits of iron ore in India. The deposits in Bihar, Orissa, the Central Provinces and Bengal are all geographically close to coking coal, but only the deposits in Bihar and Orissa are being worked now, those in the Central Provinces being also important and usable later on. The Mysore Iron Works use charcoal as a smelting medium and will probably have to turn to electrical energy. The magnetite deposits in the Salem District of Madras will eventually have to be smelted by electricity which is already available from the recently-completed Mettur Project. In addition to the hæmatite and magnetite

ores, there are very large resources of low grade iron-ore in the laterite deposits of India and the iron-stone shales of the Raniganj Field. Some of these may be used in the future when the richer ores become exhausted. It is thus evident that the reserves of iron-ore, even of good quality only, far exceed the available reserves of coking coal. It should be added that, for the purpose of general comparison, a ton of iron-ore may be said to require one ton of coking coal because the production of one ton of pig iron requires a furnace charge of 1·5 to 2 tons of iron-ore and 1 to 1·5 tons of coke, each ton of coke representing 1·3 to 1·5 tons of coking coal.

131. Though iron-smelting does not necessarily require coke, it is easily the most important fuel used for the purpose at present particularly when cheap production in large units is aimed at. Even complete stowing would only increase the percentage of recovery from 50 to 90 or 95 at the best, and would not quite double the expected life of the available reserves of coking coal. The position is therefore far from reassuring unless non-coking coal of good quality can be used for metallurgical purposes. This is a matter which must receive the serious attention of the iron and steel manufacturers who seem at the moment to be increasing their industrial activities.

132. Limits of Conservation.—Assuming that the imperative necessity of conserving the limited reserves of good quality coal has been established, the next obvious question is the measures that should be taken to achieve this object in the national interest. The first point for consideration in this connection is whether State control in the interests of conservation should be general or restricted to any particular field or fields. Of the 43 witnesses who gave evidence on this point, 2 said that they did not consider that any case had been made out for conservation, 9 were in favour of the conservation of coking coals only, and 32 advocated the conservation of all good quality coals. The arguments for general conservation were:—

(1) that the criterion should be the interest of the whole community and not the interest of any particular industry or trade,

(2) that all good coal is of national and commercial value,

(3) that the reserves of good steam coal, though not so limited as the reserves of good coking coal, are yet limited in comparison with the expected industrial life of the country,

(4) that the conservation of coking coal for metallurgical purposes only would increase the demand for steam coal for other purposes, and so further limit the available reserves of such coal, and

(5) that high volatile coals of the Raniganj series are particularly suitable for hydrogenation, a process which, with

the even more limited reserves of oil, will before long have to be more generally adopted.

133. CONSERVATION OF COKING COALS ONLY.—The main arguments in favour of the conservation of coking coals only are that, without stowing, the available reserves are limited to a short half century or so, and that coking coal is essential to the smelting of iron-ore of which the reserves are comparatively much larger and of good quality. We may concede at once that the necessity for the conservation of coking coals by compulsory stowing or otherwise is greater than for other coals of good quality, not only because the available reserves are smaller, but also because mining conditions in the Jharia Field, from which most of the coking coal comes, are particularly difficult and dangerous. But this does not mean that conservation should therefore be necessarily restricted to coking coals. The annual production of good coking coal is now about 13 million tons, but the iron and steel industry and the coke-oven plants absorb only about 2·5 million tons of this output, the remaining 10·5 million tons being used for steam raising. If the use of coking coal were prohibited by law for any other than metallurgical purposes, the collieries producing the above 10·5 million tons would have to shut down and either be adequately compensated or acquired by the State. The demand for good quality steam coal would then be more than doubled and, as we have already seen, the life of the reserves would be shortened to a period little better than that of the reserves of good quality coking coal. It is possible of course that part of the increased demand for steam coal would be met from the comparatively inferior qualities, but with prices at anything like their present level the bulk of the demand would probably be transferred to good quality coal.

134. Besides, there appears to be little real justification for the argument that coking coal should be conserved for metallurgical purposes because it is indispensable and irreplaceable in the smelting of iron-ore. Messrs. Tata's (W. No. 64) said in this connection that " high grade coke is essential for iron-ore smelting ". It was admitted that iron-ore can be smelted by other means, but it was said that there is no probability of this becoming a commercial proposition in the near future. The recently amalgamated Indian and Bengal Iron and Steel Companies (W. No. 65) said that neither good quality coal nor coke made from semi-coking coal would be sufficiently strong to enable the smelting of Indian iron-ore to be carried out in large furnaces as such smelting is carried be done economically. It was added that electric smelting is carried out in one or two instances where power is very cheap. On the other hand, Dr. Fox (W. No. 35) of the Geological Survey gave evidence as follows:—

" I think that the subject of caking or coking coal should not be allowed to confuse the issue of conservation because it is my definite opinion that non-coking coals can at present be used for metallurgical purposes, either directly or by being rendered coking and coked, and that the iron and steel makers know

that this can be done. I refer particularly to the use of such coal or coke in small furnaces, but I think that, even in larger furnaces, if the furnace is started with coking coal, certain non-coking grade I and some grade II coals could be used, provided moisture was less than 4 per cent., and volatile content more than 16 per cent. Furthermore, the direct use of powdered fuel firing at the twyers of blast-furnaces also awaits trial. The position is therefore that, if the reserves of coking coal were approaching exhaustion because they were being used for other than metallurgical purposes, the iron and steel companies would be compelled to turn their attention to non-coking coals and to use them in some such manner as I have indicated."

In addition, we have seen a letter of the 1st December 1936 from the late Mr. Charles P. Perin (who was well known in India) forwarding a letter from an American Coke Oven Corporation saying that coal up to about 36 per cent. volatiles is being used by them and is producing a fairly good blast furnace coke. Mr. Perin himself added:—

"I think Sir Lewis Fermor was all wrong in his limitation of the life of the coking coals of India. I do not think he realised what could be done with mixing coking coal with non-coking and carrying the temperatures higher."

There seems therefore to be no good reason for disputing Dr. Fox's conclusion that "owing to large and cheap supplies of good quality coking coal being available for metallurgical purposes, the iron and steel makers have not really tried to see how far good quality non-coking coal could be used equally efficiently for metallurgical purposes".

135. If the iron and steel industry is really perturbed about the available reserves of coking coal, it should itself take steps to acquire a sufficient interest in those reserves to enable it to continue the smelting of iron-ore with coking coal for a longer period than now seems likely. Messrs. Tata's began by telling us that their own resources of coking coal are estimated at 200 million tons and that these reserves represented the amount available for despatch. The witness (W. No. 64) who represented them went on to say:—

"With proper conservation our resources may last for a hundred years, but, if the surrounding collieries subside, or get flooded or catch fire, it may be impossible to mine more than 50 per cent. of our reserves which will be reduced to 50 years. As an organisation, the Tata Iron and Steel Company is in favour of State control or any other method for putting a stop to bad working, fires, floods, etc."

As regards the amalgamated Indian and Bengal Iron and Steel Companies, their representatives (W. No. 65) admitted that "our reserves are definitely limited". Yet these companies, and the Tata Iron and Steel Company also, have been selling coking coal from their own collieries in the open market for steam raising

purposes and purchasing slack for their coke ovens. They told us that this practice has ceased or is about to cease, but we know that one of them tendered for a State Railway contract this year and then withdrew that tender after this Committee commenced to take an interest in the subject. While we should not like to go so far as to say that the changed policy of these companies regarding the sale of coking coals for steam purposes has been due to our enquiry, we are strongly of opinion that they should be required by the Government of India to guarantee that they will not in future sell coking coal from their own collieries in the open market. If they will not give this guarantee, the tariff protection now enjoyed should be withdrawn or modified. We may note that one peculiar consequence of these protective arrangements is that these companies are able to demand about Rs. 60 a ton for pig iron in their nearest markets in Bengal because they have a monopoly, about Rs. 40 a ton in Madras where there is one competitor, and only about Rs. 25 a ton for exports to Japan which are increasing rapidly. We are not directly concerned with this apparent anomaly, but we are entitled to assume from it that the iron and steel companies are well able to look after themselves and that no measures of conservation in their interests would be justified. The representatives (W. No. 64) of the Tata Iron and Steel Company told us in fact:—

> "We have decided to protect ourselves at our own expense; we have decided to stow where necessary, *i.e.*, in seams over 13 feet thick. We are leaving 300 feet coal barriers in any new areas we open out. But we are not prepared to pay for the protection of others. We do not want any help."

136. Conclusion.—We are of opinion therefore that any legal measures of conservation should apply to all good quality coals and should be introduced as a matter of public policy in the interests of the community as a whole. The best means of conservation, apart from the incidental benefit derived from measures of State control over mining methods, is stowing, and this subject will be dealt with in all its aspects in a later chapter.

CHAPTER VII.

Special aspects of Waste and Conservation.

137. RESPONSIBILITY OF LANDLORDS.—As they have a direct financial interest in the royalties payable on every ton of coal taken out of their properties, landlords might reasonably be expected to frame their leases so as to guard against avoidable waste and secure the largest possible recovery of the coal *in situ*. Their title to mineral rights in the permanently-settled tracts of Bengal and Bihar is derived from a Despatch of the Secretary of State for India, No. 35-Revenue (Minerals) of the 25th March 1880. The relevant part of this Despatch is quoted at page 6 of the 1920 Coalfields Committee's Report, the ground for the concession being that, even if the legal right of the State to minerals in the permanently-settled tracts could be established, it would not be advisable to enforce it. The Secretary of State expected that these *zemindars* would be " sufficiently alive to their own interests either themselves to develop the mineral resources their estates may contain, or to afford facilities to others to do so ". This expectation has not been realised partly because the *zemindars* had neither precedent nor experience to guide them, and partly because they were unable to resist the lure of large sums of ready money. Valuable properties and rights were parted with for comparatively small considerations, and the future was left to look after itself, little or no provision being made for the proper working of the properties or the proper exercise of the leased rights.

138. In paragraph 8 of their Report, the 1920 Committee said:—

> " In paragraph 14 Mr. Rees points out that their is no supervision to prevent wasteful methods of working, and in paragraph 17 that landlords have not in the past availed themselves of expert advice. We consider these remarks to be justified. The English " landlord's agent ", in the ordinary sense of the term, does not exist in India. In certain leases indeed conditions are inserted (1) that the lessee shall afford the lessor or his agent all reasonable facilities to enter into and inspect the mines, (2) that coal-mining operations shall be carried on in " as skilful and workmanlike a manner as possible ", (3) that they shall be conducted in accordance with rules and regulations from time to time promulgated by Government, (4) that the lessee shall do as little damage as possible to the surface and the buildings and other erections thereon, and (5) that the lessee shall indemnify the lessor against the damage he may suffer through negligent working.
>
> In practice, however, we find that these provisions are inoperative. No landlord employs a competent agent to

inspect his tenants' mines and to safeguard his interests, any supervision exercised being confined to the prevention of fraudulent evasion of royalty."

The evidence given before us indicates that there has been no improvement in any of these respects. With two notable exceptions (the Kasimbazar Raj Wards' Estate and, in a lesser degree, the Burdwan Estate) no landlord has employed a competent mining engineer to look after his interests, to advise him over his leases and to find out how his property is being worked. The Kasimbazar Raj Wards' Estate has adequate leases, but its representative (W. No. 58) admits that the present detailed conditions in the leases date only from 1922, when a competent mining engineer was appointed for the first time, and would not have been obtained unless that mining engineer had been appointed. He also gives several instances in which, prior to the employment of the mining engineer, coal companies worked their leased coal with a view to speedy profit and so lost considerable quantities of that coal for ever. Though it does not appear in the Burdwan Estate evidence (their representative did not appear for oral examination) we are aware of a case in which a coal company, managed by one of the biggest firms in Calcutta, was found to be working the lower Poniati seam of selected grade to the immediate damage and ultimate loss of the upper Koithi seam of grade I quality. After protracted negotiations conducted by the Kasimbazar Estate mining engineer who was then working for the Burdwan Estate also, the company agreed to pay compensation and an additional royalty on coal extracted from the Poniati seam. The landlord was compensated to some extent, but the coal in the upper seam, which is definitely of commercial value, has been, is being and will continue to be lost. The amount of that coal has been reliably estimated at $3\frac{1}{2}$ million tons. In another case, the same Estate accepted the unsupported word of another company's colliery agent to the effect that the Koithi seam was valueless and did not therefore claim any compensation. Even without skilled inspection, the Panchkote Raj has, according to its representative (W. No. 57) discovered some of their lessees working improperly and has taken steps against them with the following results:—

"The first of these was the . . . . . Company whom we had to sue for breach of covenant in that they were not submitting the returns required by the leases and were also working in-stroke and out-stroke against the terms of their leases. We were successful in getting the property back in *khas* and then made a fresh settlement with Messrs. . . . . We raised the royalty from annas 4 to annas 7. We were also paid three lakhs of *salami*.

The second case was that of the . . . . Company belonging to Messrs. . . . . This Company had leased our Dumurkunda property and had been working it for 12 years through their

Chanch Colliery. The dispute was compromised by the Company paying us Rs. 22,000 as compensation.

The third case was also one in which the . . . . had been working our Radanagar property leased to them through their Chotadhemo Colliery belonging to the Kasimbazar Estate. This had been going on for six years. The Company paid us Rs. 50,000 amicably as compensation. Since then they have been paying us royalties.

There was also a fourth case in which the . . . . managed by . . . . was sued for bad working on our property. They had to pay Rs. 8,000 as damages. The bad working consisted of loss of coal due to an area being allowed to collapse in the part of the mine which was not being worked at the time."

The same representative said:—

"My proprietor used to trust the bigger European firms to work properly, but he has now been disillusioned in so far as the honest payment of royalty is concerned. He has not been in a position to ascertain anything about the methods of working."

139. The instances cited are sufficient to establish the proposition that, generally speaking, the permanently-settled *zemindars* have not controlled their lessees properly even in their own interests, and have in consequence not only lost their royalties on very large quantities of coal, but have also caused the country's coal resources to be correspondingly depleted. It is obviously no use having terms in leases requiring mining to be done in a business-like manner and according to the rules laid down by the Mines Department, if the mines are not inspected competently to see whether these terms are being observed. Further, W. No. 58 says that "such conditions in the old leases as not being allowed to drop the surface on any account, or having to apply for permission with further *salami* before pillars could be extracted, were definitely detrimental to the efficient working of the mine, because they encourage the lessee to extract as much coal as possible in the first working". The representative of Nowagarh Raj Estate (W. No. 61) agrees that "if the landlords have not looked after their coal mining interests properly, Government should step in and appoint an authority both in the interests of conservation and in the interests of the landlords themselves. I agree that, if my landlord had been properly advised at the time by a competent mining engineer, he would not have given leases of the kind that have been given." We agree entirely with all this, but would add that the action taken should be in the national interest and that the landlords should pay for the protection incidentally given to them by direct contributions towards the general cess (which we shall deal with in detail later) to be administered by the Statutory Authority. The control to be exercised by laying down principles of first working by regulation, and by giving the Statutory

Authority power to regulate depillaring, section-working, rotation of working and stowing, will eradicate most of the worst evils of of the present system of negligent landlords and acquisitive lessees, but it will be necessary also to give the Statutory Authority power to supervise and control the terms of new leases so far as technical matters are concerned, the parties being left to settle among themselves terms as to royalty rates, surface rents and initial *salami*. Subsequent *salami* for allowing extraction of pillars should be prohibited in future as was suggested in paragraph 10 of the 1920 Committee's Report. The control should extend to securing leaseholds of adequate sizes and more or less rectangular boundaries, and also periods of leases sufficient to facilitate the use of sound mining methods.

140. PROPORTIONATE OUTPUT FROM COAL IN PILLARS.—In other parts of our Report, we have referred to the far larger proportion of the total output of coal that is now being obtained from pillars. In 1920, the percentage was 25; by 1927 it had increased to 32 (for Jharia only). According to our evidence, which does not of course cover all the collieries in the Raniganj and Jharia Fields, the percentage output from pillars is anything from *nil* to 100 per cent. in different collieries, while the opinion of the Chief Inspector of Mines is that the general average over both Fields is between 50 and 60 per cent. Judging partly from the evidence before us, and partly from our knowledge of both Fields, we are inclined to put the average percentage at over 60. This percentage will of course go on increasing as the virgin areas and seams awaiting development diminish until, as the resources approach exhaustion, the whole output will have to be recovered from pillars.

141. AMOUNT OF COAL IN PILLARS.—The Chief Inspector of Mines has especially collected for us the following figures of the amount of coal now standing in pillars in all the principal coalfields:—

	Selected and Grade I.	Grade II and inferior.	Total.
Jharia Field . . .	162,991,160	52,052,584	215,043,744
Raniganj Field . . .	132,555,750	20,967,972	153,523,722
Total of Jharia and Raniganj Fields . .	...	...	368,567,466
Giridih Field . . .	10,551,248	*Nil*	
Central Provinces Fields .	*Nil*	13,930,730	
Bokaro Field . . .	2,554,741	14,000	
Karanpura Field . .	1,422,933	1,666,704	
Total of all Fields .	310,075,832	88,631,990	
			398,707,822

142. PERCENTAGE OF PROBABLE RECOVERY.—Our witnesses were asked to state the percentage of pillar coal actually being recovered in their own collieries. The percentages given by them vary considerably and, excluding the figures which relate to seams less than 12 feet thick, they cannot be regarded as reliable because experience shows that complete records of depillaring operations are very rarely kept. For example, such calculations do not usually take into account losses in internal barriers nor pillars which are lost entirely.

143. Taking into consideration the average size and condition of the present pillars, the extreme thickness of many of the seams, the period for which most of the pillars have been standing, the thin parting between many adjacent seams standing in pillars, and the methods by which the pillar coal will have to be recovered without stowing, we are of opinion that, unless stowing is introduced on a fairly extensive scale in the Jharia and Raniganj Fields, the percentage of coal recovered from standing pillars will not be more than 60 per cent. in the Raniganj Field, while it is extremely doubtful whether it will reach 50 per cent. in the Jharia Field. These percentages take into account both wastage from present methods of working and probable losses from collapses and fires.

144. As regards the Bokaro and Karanpura Fields, they have been opened comparatively recently and the amount of underground work done is very small, but considering the thickness of the seams in these two Fields, we are definitely of opinion that, when depillaring has to be done, it will be at least as necessary to stow as it now is in Raniganj and Jharia.

145. As regards the Giridih Field, we have ascertained that, in the Giridih State Collieries which cover practically the whole field, the total amount of coal left for extraction is about 15 million tons of which about 1 million tons is under rivers and roads and cannot be recovered without stowing. It will be for the Statutory Authority to decide the extent to which compulsory stowing will be necessary here in order to secure the maximum amount of the coal available. The figures given to us indicate that very nearly 5 million tons of coal have been lost already in barriers and shaft pillars and can never be recovered at all.

146. As regards the Central Provinces Fields, they will be dealt with in a separate chapter, but we may say here that the evidence given to us on the spot indicates that, in the Chanda Field where the seams are thick and the coal even more liable to spontaneous combustion than Raniganj coal, pillars cannot be recovered at all without stowing.

147. HISTORY OF COAL GRADING BOARD.—This subject is not mentioned specifically in our terms of reference, but we were asked later by the Government of India to enquire into "the effect on methods of extraction of the Coal Grading Board Act XXXI of 1925". This Act came into force on the 23rd September 1925, the

Statutory Rules were passed on the 19th December 1925, and the Grading Board commenced work on the 6th January 1926. The action so taken followed promptly on the Report of the Indian Coal Committee of 1925 which was appointed on the 20th September 1924 and reported on the 28th March 1925. The terms of reference to that Committee directed enquiry and report:—

(i) on the measures necessary to stimulate the export of suitable coal from Calcutta to Indian and foreign ports, and

(ii) in particular, whether effective measures can be taken for the pooling and grading of Indian coal for export and for bunkering, and how the cost of such measure should be met.

The Committee was considered necessary because the foreign trade had practically disappeared. After the War, the internal demand for coal increased and wagon supply was very deficient. On the 24th July 1920, the Government of India prohibited export except under licence and then discontinued, from the 1st September 1920, the preference hitherto given by railways to bunker coal for Indian ports. A rationing scheme was drawn up, but further restrictions had to be imposed in 1921. In April 1922, the restrictions on the shipment of cargo and bunker coal to Indian ports were removed, but the embargo on exports out of India remained till the 1st January 1923. The railway rebate on coal exported was restored from the 1st January 1924, but the foreign markets had meanwhile been lost and other suppliers had established a firm footing therein. It was generally admitted also that the quality of Indian coal exported had been very unsatisfactory, and that foreign consumers were unable to rely on regular supplies of uniform quality.

148. We have dwelt on these details in order to bring out the point that the only object of the Government of India and the Committee of 1925 was to improve the quality of export coal and regain foreign markets. The Committee recommended (see page 133 of their Report) that "a Grading Board should therefore be immediately established which would grade collieries which produced coal for export and would arrange the issue of a certificate for each consignment of the coal exported". The Committee went on to say that "any coal should be eligible for inclusion in the grading list", but paragraph 105 of their Report indicates clearly that "grading should be done from the point of view of consumers overseas" and that, though any coal, however bad, was to be graded if the colliery concerned so wished, the coal must be intended for export. When the Act was passed, however, Section 4 allowed any colliery to apply for grading and required the Grading Board to determine "the grade of coal of all or any of the seams or of a part of a seam of such colliery". It is this provision that has enabled grading to be extended to coal not intended for export with the result that almost all coal produced in the Bengal and

Bihar Fields is now offered and bought under the Grading Board classifications.

149. STATISTICS OF EXPORT TRADE.—The export trade is confined almost entirely to the port of Calcutta and to coal from the Jharia and Raniganj Fields. The statistics (Tables VI and VII) annexed to our Report show that this trade, consisting of coal shipped as cargo to foreign and Indian ports, is only a very small proportion of the total tonnage produced, and that the foreign exports form an equally small proportion of the total exports. The position in 1935 and 1936 was as follows:—

Year.	Total output.	Exports to foreign ports.	Exports to Indian ports.	Total exports.	Percentage of exports to total output.	Percentage of exports to foreign ports to exports to Indian ports.	Percentage of exports to foreign ports to total output.
	Tons.	Tons.	Tons.	Tons.			
1935	16,593,615	217,584	1,649,090	1,866,674	11·2	13·1	1·3
1936	16,052,388	195,836	1,441,579	1,637,415	10·2	13·5	1·2

It should be added that, though the foreign export trade is insignificant as compared with the internal trade, it exceeds considerably the import trade, the amount imported in 1935 being 77,075 tons or 35·4 per cent. of the foreign exports. According to Appendix "D" of the Coal Grading Board's Report of 1935, the more important ports to which graded coal was shipped that year were:—

Foreign Ports.	Tons.	Ports in British India.	Tons.	Ports in India, but not in British India.	Tons.
Colombo . .	157,325	Rangoon . .	512,021	Marmagoa .	102,604
Hongkong .	45,589	Bombay . .	481,709	Port Okha .	49,010
Singapore . .	16,689	Madras . .	90,029	Bhavnagar .	44,719
		Karachi . .	78,766		
Aden . .	8,380	Tuticorin .	47,053	Verawal .	38,488
Durban . .	3,987	Chittagong .	36,615	Porbandar .	30,623

150. CONCESSIONS TO EXPORT TRADE.—It should be remembered that, in addition to authoritative and reliable grading, the export

trade is assisted by the following concessions not enjoyed by the internal trade:—

(1) A rebate of 37½ per cent. of the actual freight rate (including the surcharge of 12½ per cent. with a maximum of Re. 1 per ton irrespective of distance) on graded coal shipped under certificate. For ungraded coal, the rebate is 25 per cent. Bunker coal consigned to Calcutta used to be exempted from the 12½ per cent. surcharge, but this was withdrawn from the 1st November 1936.

(2) An additional rebate of 8 annas a ton on graded coal from the 1st October 1936.

(3) A rebate of 50 per cent. on river dues (equivalent to 4 annas a ton) on graded coal shipped under certificate.

151. EFFECT ON EXPORTS.—In spite of all this, shipments of cargo coal have been declining steadily in recent years, the actual figures since 1926, when the Grading Board commenced operations, being:—

Year.	Cargo exports to foreign ports.	Cargo exports to Indian ports.
	Tons.	Tons.
1926	617,573	1,435,110
1927	576,167	1,682,802
1928	626,343	1,633,518
1929	726,610	1,860,602
1930	461,188	1,556,569
1931	441,249	1,686,095
1932	519,483	1,652,853
1933	426,176	1,425,039
1934	330,233	1,536,894
1935	217,584	1,649,090
1936	195,836	1,441,579

152. STATISTICS OF GRADING.—It may thus be taken as established:—

(1) that the grading of coal for the internal trade was not intended originally, and

(2) that the export trade is relatively small and has actually decreased so far as foreign trade is concerned; this decrease is probably due mainly to external competition, and it is possible that the foreign trade would have disappeared altogether without grading.

Appendix "K" to the Coal Grading Board's Report of 1935 shows 416 graded seams of which 215 are graded in their full thickness and 201 in one or more sections. Of the 416 gradings, 212 are of selected grade, 159 of grade I, 33 of grade II and 12 of

grade III. Of the 215 fully graded seams, 143 are in the Barakar Series and 72 in the Raniganj Series. Of the former, 75 are selected, 42 grade I, 19 grade II, and 7 grade III; of the latter, 45 are selected, 23 grade I, and 4 grade II. Where parts of seams have been graded, the ungraded sections vary from a few inches to over 20 feet. For example, in No. 10 seam of the Godhur Colliery, 10 feet 2 inches is selected grade and 22 feet in the roof is ungraded. In the Bottom Ramnagar Seam of Pit No. 4 at the Victoria Colliery, the section of the seam is 3 to 4 feet ungraded in the floor, 17 feet selected, 8 feet ungraded between the two graded sections, 10 feet selected and 2 inches ungraded in the roof.

153. GRADING SYSTEM.—The following are the classifications on which grading is done:—

Low volatile coal or Barakar Series.	High volatile coal or Raniganj Series.
Selected Grade.	
Up to, but not exceeding 13 per cent. ash. Over 7,000 calories.	Up to, but not exceeding 11 per cent. ash. Over 6,800 calories. Under 6 per cent. moisture.
Grade I.	
Up to, but not exceeding 15 per cent. ash. Over 6,500 calories.	Up to, but not exceeding 13 per cent. ash. Over 6,300 calories. Under 9 per cent. moisture.
Grade II.	
Up to, but not exceeding 18 per cent. ash. Over 6,000 calories.	Up to, but not exceeding 16 per cent. ash. Over 6,000 calories. Under 10 per cent. moisture.
Grade III.	
All coal inferior to the above.	

The grading is determined by analyses of samples taken from the seam itself in the colliery, but only coal intended for shipment is inspected first at the time of loading on the railway to see that the coal has actually come from a particular graded seam or section of a seam, and again at the Kidderpore Docks, before a certificate of shipment is given, as regards size and cleanliness. There is no inspection of graded coal sold internally and there is therefore no Grading Board guarantee that the coal despatched by rail to a consumer, say, in the Punjab, is actually the graded coal that the consumer has ordered. Further, one witness (W. No. 28) with considerable experience in testing samples of coal from various collieries has told us that the ash percentage is invariably up to 2 per cent. higher than that shown on the Grading Board certificates.

154. EFFECTS OF GRADING.—Evidence has been given (see Statements II and III attached to the written evidence of the Chief Mining Engineer of the Railway Board—W. No. 37) that the

working of seams in sections based on quality existed before the Coal Grading Act of 1925 was passed, but we are satisfied that this method of commercial exploitation has grown considerably since, partly owing to the facilities provided for grading on which consumers think they can rely, and partly owing to low prices and generally unfavourable market conditions. The drop in coal prices began before the Grading Board was established, but it has continued progressively every year and has led more and more to concentration of working on selected grade coal. Where the seam would be grade I quality as a whole, it has been split up by sampling and analysis into a section of selected grade and an ungraded section. Only the selected grade section is extracted in the first working, and this in itself depreciates the other section and causes waste so far as quality goes. As soon as depillaring begins, the comparatively inferior section left in the roof or the floor, which has not been won in the first working because it paid commercially to work only the selected grade section, must either be recovered or left behind and lost. There is no recovery in practice, partly because the ungraded section is comparatively unprofitable or not profitable at all, and partly because the Grading Board will not allow ungraded coal to be extracted at the same time as graded coal unless the grading certificate is surrendered. The result is that the unwanted section is crushed in the goaf by the falling of the roof and so not only causes further waste so far as quantity is concerned, but also increases the risk of spontaneous combustion. Almost every technical witness who gave evidence on the point said that the extraction of a section of a seam in such a way as to leave behind the remainder in the goaf increases both avoidable waste and danger from fire. Examples were given of fires attributable to this cause in the Kajora, Koithi, Samla, Jambad and Nos. 11 and 12 seams. One witness (W. No. 22) told us that the Koithi seam of the South-East Baraboni Colliery had been mined and depillared extensively without leaving any roof coal and without any signs of heating or fire. After 8 feet of the seam was graded as selected, leaving 4 feet 6 inches of inferior coal in the roof, this coal was left in the goaf and caused a fire within a few months.

155. It must be admitted that there is much to be said for the grading system. It has introduced and standardised the classification of Indian coals by uniform methods of sampling and analysis, and this classification has been helpful to consumers who have a definite basis for their orders as long as the colliery remains on the grading list. Stability both during first working and depillaring has been improved because galleries have not been so high as when the whole seam was worked at once. Yet it remains true that avoidable waste of coal of commercial value has increased appreciably, while the danger of fire following local and main falls of roof has also been increased.

156. Points for consideration.—The first point for consideration is whether, to suit the exigencies of commercial profit, these

prejudicial practices and results should be allowed to continue. We asked, in *Question 46* of our General Questionnaire, whether the extraction of a section of a seam so as to render unworkable the remainder of a lower grade, but still of commercial value, should be prevented or controlled. This, and the allied *Question 47* regarding seams being rendered unworkable by similar methods, are both points on which mining opinion should be unequivocally opposed to commercial opinion, but the answers show mining engineers, who should and do know better, echoing the voices of their Calcutta owners. One witness (W. No. 19) for example says:—

> "I do not think that the State can prevent a private individual from working his coal as he pleases without giving compensation even though the result of such working may be to increase dangers from fire. I think that the mine-owner should be allowed to judge for himself whether he should take the risk or not."

Another witness (W. No. 21) says:—

> "The owner of a colliery is the best judge of what is commercially valuable and his ability to work and sell at a profit any particular coal should be the criterion of its value at any time."

There are several other such opinions, but only one witness (W. No. 38) who says:—

> "After discussion with the Committee, I agree that the answer to both these questions (namely, Nos. 46 and 47 of the General Questionnaire) should be in the affirmative from the standpoint of a mining engineer."

Other evidence before us in answer to *Question 62* indicates that considerable commercial importance is attached to the export trade even though it is relatively small and steadily diminishing, and there is certainly every justification for maintaining the quality of Indian coal in outside markets and for giving overseas consumers the same guarantee of quality by authoritative grading and inspection as they obtain from South Africa which is India's chief competitor in those markets. Both commercial and technical opinion agrees generally that it is now too late to limit grading to export coal as originally intended, and we are satisfied that it would be impracticable because a colliery which is not exporting to-day may want to do so to-morrow, and would not be able to have its coal graded *ad hoc* for an export order. Besides, if the existing grading certificates were withdrawn so far as the internal trade is concerned, and no further analyses were made nor certificates issued, a particular colliery might say that it was working for the internal demand and then export its output. There would be no inspection at the time of loading nor at the docks, and Indian coal would gradually get discredited again. It has been suggested to us that, as section-working is a direct consequence, not so much

of the grading system as of unfavourable market conditions and low prices, it will disappear automatically if conditions improved and prices increased to the extent of rendering coal saleable which is now regarded as unsaleable or, in other words, of bringing into effective demand coal that is now not considered worth recovering. Even if this is correct, however, the depleted state of India's reserves of good quality coal and the paramount considerations of safety of life and property demand that section-working as a purely commercial necessity should be stopped.

157. REMEDY SUGGESTED.—We have considered various ways in which this might be done. Sir Lewis Fermor suggested that the sampling and analysis of coal for export should be done at the docks and certificates given for the coal as actually shipped. The same idea was considered and rejected in paragraph 113 of the 1925 Committee's Report, and we have been advised that it would be unsuitable practically and unacceptable to the foreign consumer. We have therefore come to the conclusion that the only satisfactory solution is to stop the grading of sections of seams and cancel the existing certificates of such grading. If any colliery, which has had its grading certificate cancelled, applies for a fresh certificate for the whole seam, it should be allowed to have this without any charge. All that is necessary to give effect to our main recommendation is to amend Section 4 of the Coal Grading Act by omitting the words " or of a part of a seam ".

158. EFFECT ON EXPORT TRADE.—This would mean, so far as the export trade is concerned, that only seams of more or less uniform quality and capable of one grading throughout could be exported under certificates of shipment. This would not constitute a hardship in practice because most of the coal now exported under certificates of shipment comes from such seams. Figures supplied to us by the Chief Mining Engineer to the Railway Board show that about 95 per cent. of the shipments are selected grade coal, and that the shipments of selected grade coal are made up as follows:—

	Non-coking coals.	Coking coals.	Total.
	Tons.	Tons.	Tons.
1935 . .	1,063,260	720,201	1,783,461
1936 . .	1,039,377	561,680	1,601,057

Of the above non-coking coals of the Raniganj series, no less than 1,017,703 tons and 1,021,347 tons respectively came from the Dishergarh, Poniati and Sibpur seams which are graded in their full thickness. These figures represent 95·6 and 98·2 per cent. of the total non-coking coals exported and 56·4 and 63·7 per cent. of the total shipments. As regards the coking coals of the Barakar series, it is not possible to give such precise figures because the quality of the seams varies within comparatively short distances and a seam which is graded throughout in one colliery often has to be graded in sections in the next colliery. The practical experience of the Chief Mining Engineer to the Railway Board has,

however, been enlisted in estimating that the coking coals from fully graded seams represent about 41·3 per cent. of the coking coal shipments and about 16·7 per cent. of the total exports. We thus arrive at the conclusion that about 80 per cent. of the graded coal cargoes now come from seams which have been graded in their full thickness. As the export trade is mainly in the hands of two or three Calcutta firms who are interested more in Raniganj than in Jharia coal, there will be no difficulty whatever in making up the remaining 20 per cent. from fully graded seams. These firms will be benefited at the expense of other firms, but this is an incidental result of our recommendation, its fundamental justification being the public interest.

159. EXPORT OF NON-GRADED COAL.—It will be necessary also to prohibit the export to foreign ports of non-graded coal of any description as is now done in South Africa. There is little or no such coal exported now, but the temptation to export it will be greater when grading is restricted to the whole seam, and no risk should be taken of Indian coal being again discredited in foreign markets.

160. EFFECT ON INTERNAL TRADE.—So far as the internal trade is concerned, the stopping of section grading will not by itself stop section-working in the interests of commercial exploitation, but it will be restricted considerably because producers will have to assume responsibility for supplying coal of the quality ordered, and consumers will have to see for themselves that the coal they get is of the quality ordered and required. The tendency will be for consumers first to satisfy themselves as to the particular coal most suited to their requirements and then to order that coal by the colliery and the seam as used to be done. In this connection, we may cite paragraph 84 of the Report of the 1920 Coalfields Committee to the effect that coal was then classified for market purposes, not according to its class, but by the name or number of the seam and by the name of the colliery producing it. We have been told that we must not lose sight of the fact that the Grading Board classifications have been accepted by the trade and relied on by consumers in making purchases. This may be so, but it is not a necessary part of a grading system for export purposes, and it is the business of buyers and sellers on the spot to look after their own respective interests by means of contracts providing for penalties and bonuses on a sliding scale according to calorific value, ash and moisture as is now being done by big consumers like Messrs. Tata's in spite of the grading classifications. It is evident that the grading of coal on chemical analysis and calorific value does not by itself show conclusively whether a particular coal is suitable for the work it is required to do. The Royal Commission on Coal Supplies said in this connection: "The more consumers realise the advantages that accrue from the use of coal selected to suit their special requirements and appliances, the more they will expect and demand uniformity of quality and size. Uniformity is

important; and there is no question that a consumer is willing to pay more if he can rely upon always getting what his experience has found to be best suited for his purpose". This can only be ascertained by experiment and experience, and it is on this basis that consumers should order their coal and stop relying on a standard classification, conformity with which in actual supply is not in any way checked nor guaranteed by the Grading Board. Besides, as suggested by us elsewhere, section-working generally will be regulated by the Statutory Authority in the interests of conservation and safety. That Authority will decide what is to be done in each case regarding coal of commercial value which a mine-owner does not propose to recover. If the inferior section is comparatively thin, the Statutory Authority would have to decide the balance of advantage between immediate recovery during depillaring or total loss, because, even if this coal were preserved intact by stowing, it could not be worked economically at a later date. It would also happen in a few cases that coal has to be left to support a weak roof. In such cases, the danger from fire will have to be averted by such means as the Statutory Authority may consider necessary. If the inferior section was comparatively thick, the Statutory Authority would decide between immediate recovery and leaving the coal in such a condition by stowing that it could be recovered subsequently when market conditions were more favourable. The inferior coal could for instance be sorted on the surface and sold to soft coke manufactures. In order not to interfere unduly with such existing contracts as provide for the supply of coal on a grading certificate basis, the Statutory Authority should be legally authorised to take action in such cases after allowing a reasonable period for the revision of the contract. In any event, if the Statutory Authority is to have a fair chance of controlling section-working properly, it would certainly be undesirable to have any conflict between its aims and powers and the practical effects of the Grading Board's operations. It is therefore essential from this point of view also to restrict grading to the full thickness of the seam.

161. Grading Board Funds.—There is only one more point in this connection. The Chief Mining Engineer to the Railway Board (W. No. 37) has told us that the net average annual income (*i.e.*, the difference between the fees for grading and inspection and the cost of supervision) of the Grading Board is about Rs. 55,000 and that the accumulated surplus is Rs. 3,12,000. The fees paid for grading, but not the fees paid for inspections at the docks, will be smaller if our recommendations are accepted, but the present cost of supervision could also be reduced probably to some extent. We recommend therefore that half of the accumulated surplus, and half of the future net actual income, should be handed over to the Statutory Authority and added to the proceeds of the general cess to be suggested later for the benefit of the coal trade and industry as a whole.

162. COAL LOCKED UP UNDER RAILWAYS.—Coal, mainly of good quality, is reported to lie under the lines and sidings of the two railways concerned, to the following extent:—

	Tons.
East Indian Railway	81,247,816
Bengal-Nagpur Railway	55,895,074
Total .	137,142,890

The East Indian Railway figures cover only coal in respect of which notices under section 4 of the Land Acquisition (Mines) Act have been received, while the Bengal-Nagpur Railway figures include all coal up to a depth of 1,000 feet. In 1931, the Chief Mining Engineer to the Railway Board estimated that the total quantity of coal in all seams of commercial value lying under these two railways up to a depth of about 1,000 feet was 421,000,000 tons of which 52 per cent. or 218,920,000 tons was recoverable and consequently subject to the compensation clauses of the Land Acquisition (Mines) Act so far as it would be required to be left for support. Taking into consideration extensions since 1931, and allowing for coal (i) which has already been lost because, owing to the seam having been goafed on both sides of the railway line, it is no longer accessible, (ii) which would be lost in the course of recovery by present methods, and (iii) which could be extracted without risk to the railway or by diverting or packing the track, it is evident that the tonnage which, without adequate stowing, will have to be sacrificed for support runs into hundreds of millions, the compensation payable on which, calculated in terms of working profits, would amount to much more than the railway administrations can contemplate with equanimity, and the compulsory payment of which must recoil mainly on the coal trade as a whole.

163. GENERAL CONSIDERATIONS.—The problem of coal locked up under railways is complicated. On the one hand, it is argued that, as the railways pay without question for the surface land over which they operate, they should pay also for supporting coal subjacent and adjacent to that surface. They purchase surface rights under the Land Acquisition Act and they can acquire mineral rights by the same procedure. If they do not so acquire the coal considered necessary for support, they should pay for it subsequently at least to the extent of the profit that could reasonably be expected from working it. On the other hand, it is pointed out that there is a common law right to vertical and lateral support, and that this right is recognised and paid for by collieries when agricultural land is damaged by subsidence. Any common law right may, however, be superseded by statute, and this is what has happened, so far as railways are concerned, both in Great Britain and India, the respective enactments being The Mines (Working Facilities and Support) Act of 1923 and the Land Acquisition (Mines) Act of 1885. So long as the latter Act remains

on the statute book, royalty-receivers and mine-owners in the permanently-settled areas of Bengal and Bihar, where the minerals no longer belong to the State, are legally entitled to compensation for coal required to be left for support. The position is different in the Central Provinces where the 1885 Act does not apply, and where the mine-owners are not entitled to get the coal under railways. The standard form of lease given by the Central Provinces Government prohibits mining operations or workings under any railway line or at any point within 50 yards of railway land. Previous permission in writing has to be obtained before any coal can be taken out, and the mine-owner must necessarily accept any conditions or restrictions that may be laid down without having any claim to compensation. So far as Bengal and Bihar are concerned, the railway contention is that the right to compensation has in turn been contracted away by almost all mine-owners, who have not only agreed to waive claims to compensation, but have also bound themselves to compensate their landlords for loss of royalty on the coal which could have been recovered if it had not been required for support. This has been done by what are known as Memoranda of Terms or Assisted Siding Agreements executed by mine-owners (but not by royalty-receivers) before the sidings are put in, and it has never been authoritatively decided, so far as we are aware, whether these Agreements are legally valid to the extent of extinguishing or limiting the statutory right to compensation created by the 1885 Act.

164. Assisted Siding Agreements.—The East Indian Railway now has 400 Assisted Siding Agreements, while the Bengal-Nagpur Railway has 131. It is freely alleged that these railways have practically compelled mine-owners to execute these Agreements by declining to put in sidings, which are of course essential to the sale, despatch and utilisation of extracted coal, unless all rights to compensation are first waived or covered by indemnity. Against this allegation that they have evaded their statutory liability by refusing transport facilities, the railways assert that sidings and their support should be regarded as a part of colliery working expenses, and that they cannot fairly be expected to carry out work which must involve them in very large liabilities without taking steps to safeguard themselves. There is every justification for a business deal over a required siding, terms as to the proportion of the whole cost to be paid by the coal company and the railway respectively being determined in each case by such considerations as the number of collieries to be served and the traffic to be expected. Such terms might even cover support for the siding itself, but the railways have demanded and obtained much more. The East Indian Railway has paid comparatively little compensation, and the Bengal-Nagpur Railway has paid none at all. Yet, under the Assisted Siding Agreements, each coal company concerned has to pay in advance for the cost of surveying a siding and preparing plans and estimates. It then has to deposit the estimated cost of purchasing the necessary surface land under the Land Acqui-

sition Act, but has no right in that land which vests absolutely in the railway. The coal company further accepts financial responsibility for all work to sub-grade (*viz.*, earthwork, bridging, ballast, etc.) and subsequent ordinary maintenance of such work, the railway providing and maintaining the permanent way materials (*viz.*, sleepers, rails, fastenings, points, crossings, etc.). It may be mentioned here that, though the Agreements do not seem to contemplate a deposit of the estimated cost of sub-grade work unless that work is to be done by the railway, we are informed that the deposit is required even when the work is to be carried out by the coal company on contract. This locks up a considerable amount of capital and seems to be unnecessary. When constructed, the siding is open to all traffic and may be extended as required. Over and above all this, the coal company undertakes—

(i) not to work so as to endanger or damage the siding or any other part of the railway administration undertaking,

(ii) to waive all claims to compensation for any prohibitions or restrictions imposed on the working of minerals " in or under any land forming part of the siding or of the said undertaking ", and

(iii) to be liable for all compensation payable to any other person in respect of minerals " in or under any land forming part of the siding, and in or under any land on either side thereof, in which such prohibitions or restrictions may be required for the purpose of lateral support ".

It will thus be seen that the Assisted Siding Agreements—

(i) cover lateral support which is not provided for in the Land Acquisition (Mines) Act,

(ii) transfer to the coal company liability to pay compensation for locking up coal to royalty-receivers and any other persons interested in the working or getting of that coal, and

(iii) extend not only to the siding concerned, but also to main and branch lines.

In 1935, the East Indian Railway put forward a revised form of Assisted Siding Agreement which was intended to afford the railway complete protection against the claims of superior landlords and intermediate lessees. This was objected to and, after discussion with the mining interests in Calcutta, the Railway Board eventually agreed (in letter No. 1401-W. of the 29th October 1935) that " for a period of two years, the East Indian Railway Administration will not insist upon the new Assisted Siding Agreements being signed by the colliery owners, and that the latter will not put in any claim for compensation in respect of coal locked up under railway lines, or for restrictions imposed in working collieries

under the railways or otherwise, and that during this period colliery owners requiring railway facilities should be required to sign the old form of agreement". It was added that the period of two years was to be utilised by both parties in examining the whole question in order to ascertain the best way to deal with the situation.

165. PREVIOUS SUGGESTIONS.—The present deadlock was perhaps inevitable in the circumstances, and it seems unlikely to us that, in the absence of any authoritative legal ruling meanwhile, the truce of two years will produce any change in the attitude of either of the parties principally concerned. Even before the Coalfields Committee of 1920, it was recognised that the railways could not possibly pay all the compensation that might be legally demanded under the 1885 Act. It was accordingly suggested, with the concurrence of the Indian Mining Association and the Indian Mining Federation, that the Land Acquisition (Mines) Act of 1885 should be amended to provide for a cess of 2 annas per ton on all coal to be credited to a Coal Mines Compensation Fund administered by trustees and intended to be used—

(i) for paying for reasonable and safe diversions which would release the supporting coal, and

(ii) for paying compensation under the 1885 Act when the working of supporting coal had to be prohibited or restricted.

The Coalfields Committee of 1920 suggested that this cess should be absorbed in their suggested 8 anna cess for financing compulsory stowing, but no action was eventually taken either on this recommendation of the Coalfields Committee or on the proposed amendment of the 1885 Act. When the proposal for a cess was first under consideration, the Indian Mining Association wrote in letter No. 98-R. of the 13th December 1915:—"The Association wish to emphasise the fact that the actual payment of compensation is a secondary consideration". It was added that "in view of the country's limited resources, it is of the utmost importance to the community that wherever possible the coal should be won and not wasted. This object can be attained, firstly, by confining the initial restrictions to the lowest limits consistent with safety, and secondly, before awarding compensation on what remains, by considering the possibility of diversions of the lines and sidings or the working of the coal in such a manner as to render the damage to the surface small in comparison with the value of the coal which would otherwise be lost". The Association accordingly suggested that, in order to avoid the possibility of any undue burden being placed on any individual interest, "provision should be made for a small increase in railway freight on coal for the accumulation of a compensation fund—the increase to be made at the discretion of Government at any time after giving reasonable notice, and the fund to be controlled and administered by Government and not to form part of the ordinary railway revenue".

166. BEST ARRANGEMENT WITHOUT STOWING.—Apart from considerations of conservation and the extraction of all coal within mining possibilities, the ideal arrangement would be one in which all the parties concerned were directly interested in economising support as much as possible. Conditions in the Raniganj Field, where the seams are thinner, further apart and deeper, differ in this respect from those in the Jharia Field, where the seams are thicker, closer together and at shallower depths. Each case could, however, be explored carefully by the technical advisers of Government, the railway and the coal company in order to ascertain—

(i) whether the conditions of depth and thickness of the seam permit of total extraction either with or without surface packing or protective work,

(ii) if not, whether the line could conveniently be diverted over statutory barriers or over an already subsided and settled area,

(iii) failing (i) or (ii), what the minimum requirements for vertical and lateral support should be, and by what methods the remaining coal should be extracted.

Compensation would then be payable (either by the railway or from a cess) for the coal left for support, the coal company being responsible for working the remaining coal in accordance with the restrictions laid down, and for any damage that might be caused by such working or any protective work necessary to prevent or counteract such damage. Under this procedure, the railway or the administrators of the cess would have every incentive to limit support required to the actual necessities of each case, while the mine-owners would find it advantageous to have a small margin of safety over and above the coal compensated for. As matters stand, however, the general impression in the coalfields is that the railways have been inclined to demand excessive support without taking sufficiently into consideration the thickness of the seam or the depth at which it lies. This general impression would not have arisen if the railways had always adopted the procedure which according to the Agent (W. No. 66) is now followed by the East Indian Railway. "What is done now is that every case comes up to me for my personal orders and I consider carefully, after taking the advice of technical experts, what is the minimum amount of support that may safely be demanded taking into consideration the nature of the seam, the amount of the intervening strata and surface features. It might be possible in particular cases to allow the total extraction of coal where seams being worked are at a depth of more than 500 feet. In all cases we naturally consider the possibility of a diversion or alternative alignment. We do also now try and put down new sidings with reference to the geological features and statutory barriers so as to avoid as far as possible the question of compensation arising at all. In the past, the acquisitions of surface lands for purposes of sidings used to be made entirely with reference to the amount of land required for constructing the sidings, for example, high embankment.

Nowadays we do also take into consideration the mining requirements and do not acquire more land than is necessary to provide support, or when considerable widths of land have to be acquired for purposes of borrow pits, restrictions are only applied to the extent necessary to ensure support." On the other hand, the Bengal-Nagpur Railway witness (W. No. 67) has cited several instances where the complete extraction of coal has been allowed under lines and sidings at depths from 250 to 900 feet and with seams from 9 to 15 feet in thickness.

167. THE 1885 ACT AND THE ASSISTED SIDING AGREEMENTS.—As regards the 1885 Act, it does undoubtedly confer a statutory right to compensation for coal required for vertical support. In practice, this right has been nominally relinquished by mine-owners under stress of circumstances, and it remains to be seen how far the Assisted Siding Agreements have deprived mine-owners and others of their statutory rights. One view is that these Agreements were executed under undue pressure or are contrary to public policy because railways are bound, under the Indian Railways Act, " to afford all reasonable facilities for the receiving, forwarding and delivery of traffic upon and from the several railways belonging to or worked by, and for the return of rolling stock ". We understand that, under the English law (Section 76 of the Railways Clauses Consolidation Act of 1845 and Section 2 of the Railways Private Sidings Act of 1904) there is express provision that " reasonable facilities " include facilities for the junction of sidings or branch lines with any railway administration. This is possibly what Sir Ralph Wedgwood, the Chairman of the Railway Enquiry Committee, had in mind when he expressed amazement at the attitude of the railways over this question, and explained that, in England, if a railway company wished to have a branch or main line, or a siding, over coal-bearing land, it had to decide then and there whether it would purchase the mineral rights or take the risk of being dropped. We hope that Sir Ralph has been reported correctly, but our authority is the speech delivered by the Chairman of the Indian Mining Association at the last annual general meeting of members held in Calcutta on the 17th March 1937. We believe, however, that there is nothing in the Indian law obliging a railway company to provide a siding for a colliery or other industrial concern. As matters stand, neither Local Government has issued a declaration under section 5 of the 1885 Act for several years, the railways and colliery companies having been left to settle matters themselves without Government intervention. In other words, the 1885 Act is for all practical purposes a dead letter, but it is clear that this state of affairs cannot continue indefinitely and that some workable solution will have to be found sooner or later. We have been shown a letter from the Government of Bihar (No. 6344-Com. of the 5th December 1936) in which it is said that " the Local Government do not at present intend to impose any restrictions under section 5 " on the working of the Eastern Coal Co.'s Bhowra Colliery in No. 12 seam. In this case,

the Bengal-Nagpur Railway took an agreement supplementary to the Assisted Siding Agreement from the Eastern Coal Co. after notice of intention to work had been given by the latter to the Local Government under section 4 of the Act. Under this Agreement, separate areas of the surface land acquired for the Bhowra Branch and Bhowra Sidings Nos. 3 and 4 were defined under which (i) no coal could be extracted, (ii) coal could be extracted under certain restrictions, and (iii) coal could be extracted completely. The company agreed not to claim compensation for coal left in the first two areas, to indemnify the railway against and to pay any compensation awarded to any person in respect of the prohibited or restricted working, to pay on demand the amount required to make good any loss or damage which the railway might suffer from violation of all or any of the restrictions, and to undertake and pay for any protective works that might be necessary.

168. LEGAL POSITION.—The present position is clearly unsatisfactory. The right to support is only a right to sufficiency of support and is not violated until damage has actually been done. Similarly, the right to compensation does not depend upon tort and should not arise until the mine-owner is able and ready to extract the coal. Cases in connection with notices under section 4 have usually gone on for years because, before the Local Government can publish a declaration under section 5, it has to obtain an indemnity from the railway concerned and consider a report by the Chief Inspector of Mines as to the prohibitions or restrictions that are necessary. The amount of compensation should then be ascertained in the manner provided by the Land Acquisition Act, but the railway still has to keep a constant watch on the mine-owner to see that the coal is worked in accordance with the prescribed prohibitions or restrictions, and in order to be able to apply section 13 where necessary. In an actual case decided against the East Indian Railway by the Additional Sub-Judge at Dhanbad on the 23rd September 1936 (Title Suit No. 30/5 of 1934/36—Ambalal Khora and another *vs.* Secretary of State for India) notice under section 4 was given to the Local Government in January 1929. As nothing happened for a long time after the 60 days contemplated in section 5, another notice was served on the Local Government in May 1931. The declaration under section 5 was published on the 12th June 1931 declaring the willingness of Government to pay compensation (after having been indemnified by the railway) and imposing prohibitions and restrictions on working. This declaration was withdrawn by a notification of the 3rd September 1934 after a civil suit had been instituted on the 8th August 1934. The Court held that the clause in the Assisted Siding Agreement waiving all claim to compensation did not legally preclude the plaintiffs from claiming such compensation (i) because that agreement had not been registered under section 27 of the Registration Act though it purported to extinguish or limit in future a contingent right or interest in immovable property, and (ii) because the contract was void as it offended against the legal rule

regarding perpetuities and was also bad for remoteness. The plaintiffs were accordingly given a decree for compensation with full costs. This decision has been appealed against, and it will be interesting to see what the Patna High Court rules. It should be added, however, that the Court also said that " if it be held that the Assisted Siding Agreement is valid and binding, the plaintiffs are not entitled to any decree ". A ruling of the Patna High Court (A. I. R., 1936, Patna, 513) had previously held that, notwithstanding the provisions of section 6 regarding the determination of compensation by the Land Acquisition Act procedure, the parties concerned are competent to enter into an agreement as to the amount of compensation, and this would presumably cover an agreement not to demand any compensation at all. As we have said before, the whole legal position thus turns on the validity of the Assisted Siding Agreement.

169. STOWING THE BEST REMEDY.—What is quite certain is that, whatever the legal rights may be, this whole question of coal under railway lines always involves vexatious delays, unnecessary expense on law suits, and general dissatisfaction. The compensation cess referred to above, while it would meet the claims of royalty-receivers and mine-owners, and enable railways to escape enormous contingent liabilities, would not meet the public or national consideration that no coal of any commercial value should be left in the ground for ever if it can be recovered without undue risk. Even with the most liberal restrictions consistent with safety, and with every provision for diversions, it is unlikely that more than 35 per cent. of the coal under railway lines can be recovered by the ordinary methods of working without stowing if the railway systems are to be maintained. It is evident therefore that, if conservation or maximum extraction is desirable and should be enforced, the only satisfying remedy is to stow the void created by removing the coal from under railway lines with some incombustible material which gives as secure support as the coal itself. This would enable practically all the locked-up coal to be won, and would also meet all the practical necessities of support and safety. It can be achieved by sand-stowing, a subject which will be fully dealt with by us in a subsequent chapter.

170. RAILWAY CONTRIBUTION TOWARDS STOWING.—The only point which we need consider now is whether the railways should pay for or contribute towards the cost of compulsory stowing. The Agent of the East Indian Railway (W. No. 66) agreed that " if all coal under the railway lines could be stowed so as to provide proper support, this would be of advantage to the railways, the mine-owners and the whole nation generally ". Some of our witnesses thought that the railways should pay for compulsory stowing under main and branch lines, and that the coal companies should pay where colliery sidings are concerned. It is evident that the railways will benefit in various ways, but so will royalty-receivers and mine-owners. The railways (i) will be enabled to carry out their obligations as public carriers without risk to life or property, (ii) will escape their present legal liability for com-

pensation otherwise than by resorting to Assisted Siding Agreements, (iii) no longer have to pay for diverting lines or for other protective measures such as those which are now being carried out near the Jharia railway station, and (iv) will obtain additional traffic from coal which would not otherwise be recovered and despatched. Of the above, the third is the only item which can be assessed precisely in monetary terms. We have been informed by the railways concerned that, in the last ten years, the Bengal-Nagpur Railway has spent Rs. 78,213 in the Jharia Field and Rs. 13,969 in the Raniganj Field on various measures of protection required mainly on account of underground fires, etc. During the same period, the East Indian Railway has spent for the same purposes Rs. 2,71,648 in Jharia and Rs. 30,500 in Raniganj *plus* an annual recurring loss estimated at Rs. 14,480. We are definitely of opinion therefore that the railways should contribute in some form that will directly help the authority administering any cess to finance compulsory sand-stowing in the interests of safety and conservation. A decrease in freight rates on coal has been suggested, but the Agent of the East Indian Railway (W. No. 66) has told us that the average coal haulage rate charged to the public and foreign railways is about 2·88 pies per ton-mile, while the basic cost of hauling all traffic, including coal, is 3·77 pies per ton-mile. Coal is thus already being carried at a rate which is considerably less than the cost of carrying all goods including coal. The Agent added that, while coal constitutes about 66 per cent. of the East Indian Railway traffic, the percentage of low-rated commodities traffic is about 82 per cent. This leaves only 18 per cent. of the traffic to bear higher haulage rates, and it is in respect of this particular traffic that the railway is suffering most from road competition. It is evident also that any reduction of freight rates would merely benefit coal producers and consumers, and would not add to the cess funds to finance compulsory stowing. Another idea is that the coal recovered by stowing should be charged a lower freight rate than other coal, but such differential rates would evidently be difficult to apply practically and would also probably be illegal as constituting undue preference.

171. The alternative is a direct railway contribution to the cess funds, but the railway witnesses are definitely of the opinion that, with the present relationship of coal traffic to coal freights, it would be impossible to make any such contribution without recovering it from increased freight rates on coal. In this connection, the following figures, obtained from the East Indian and Bengal-Nagpur Railways, are relevant and interesting:—

Amount (out of the total freight charged) retained by railways on each ton of coal exported.

	1912.	1924.	1935.
	Rs. A. P.	Rs. A. P.	Rs. A. P.
Jharia . .	2 4 9	2 15 5	2 7 5
Asansol . .	1 11 9	2 4 11	1 14 8
Raniganj . .	1 8 9	2 1 2	1 11 6½

Percentage of working expenses to total earnings.

	1912.	1924.	1935.
East Indian Railway .	37·63	60·63	62·57
Bengal-Nagpur Railway .	45·31	65·40	70·29

Cost (including interest charges) of hauling one ton of all goods one mile.

	1912.	1924.	1935.
East Indian Railway . . .	2·29 pies.	4·06 pies.	3·77 pies.
Bengal-Nagpur Railway . .	3·57 pies.	4·72 pies.	4·45 pies.

We have ascertained that it still remains true, as stated on page 57 of the Report of the 1925 Indian Coal Mining Committee, that "no method has yet been devised in any country in the world for separating the cost of hauling one ton of coal for one mile from that of hauling one ton of all goods one mile". The cost of hauling one ton of coal one mile may, for the reasons given at page 57 of the 1925 Committee's Report, be assumed to be less than the cost of hauling one ton of all goods, including coal, over the same distance. But the following percentages of coal traffic to total traffic (including coal) and of earnings from coal traffic to total earnings, show that the earnings from coal traffic are disproportionate to the coal tonnage hauled:—

	1934-35.	1935-36.	April to November 1936.
East Indian Railway—			
Tonnage percentage . .	54·6	53·2	55·1
Earnings percentage . .	47·1	45·6	43·1
Bengal-Nagpur Railway—	1935.	1936.	
Tonnage percentage . .	47·7	46·8	
Earnings percentage . .	29·3	29·2	

In the circumstances, we think that the best form in which the railways can contribute to a cess on all coal is by collecting that cess free of any commission. The Agent of the East Indian Railway (W. No. 66) has said in evidence that he would be prepared to recommend this. The railways now charge 5 per cent. as commission for collecting the cess on soft coke. If a cess were imposed of 8 annas a ton on coal and soft coke, and 12 annas a ton on hard coke, the total receipts would amount to about 115 lakhs, and 5 per cent. of this amount would be $5\frac{3}{4}$ lakhs. As regards the actual stowing under railway lines, it would be controlled by the Statutory Authority in consultation with railway mining engineers, and would only be done at first in those areas where the coal must be recovered immediately if it is to be recovered at all.

172. COAL UNDER PUBLIC ROADS, BUILDINGS, ETC.—The rules applicable are those made by the Bengal and Bihar Governments under section 30 of the Indian Mines Act. Notice in writing, has to be given to the Chief Inspector of Mines at least 60 days beforehand of intention to commence or extend mining operations

at or to any point within 50 yards of any ground on which public roads, etc., are situated. In the case of public roads belonging to District or Local Boards, first workings may be restricted by the Chief Inspector within 50 feet and pillars cannot be extracted "until a diversion of the road has been made or other precautionary measures taken to the satisfaction of the Chief Inspector". Some local bodies have complained of the damage done to their roads by subsidences and have suggested that the diversions should be as good in every way as the original road, but it has been decided that, under the law as it stands, a diversion is adequate if the safety of persons using the road is provided for.

173. As regards coal lying under the Grand Trunk Road in the Raniganj Field, the Government of Bengal claims this coal as its own. This claim has not been challenged in any court of law so far as we are aware, and we do not know the grounds on which it is based as against the permanently-settled zemindar. However that may be, the Local Government has directed the Chief Inspector of Mines not to allow any coal mining operations within a horizontal distance of 25 feet from a point vertically below any point on the surface boundary of the Road. These limits have been determined apparently on the analogy of Permanent Regulation 76 regarding barriers, but it is difficult to see any justification for requiring a mine-owner to leave 25 feet of his own coal as a barrier against solid coal or as lateral support for a road. The width of the Grand Trunk Road with its roadside land averages 150 feet so that the Bengal Government demands that all coal should be left unworked under a 200 foot width of which 50 feet belongs to the mine-owners on either side of the Road. The Chief Inspector of Mines estimates that the amount of coal that is so locked up in various seams up to a depth of 1,000 feet amounts to 33,301,034 tons of which the Toposi and Jambad seams containing selected and grade I coal account for about 12½ million tons. These figures do not take into account coal which has to be left outside the 200 foot width because it is separated by the Road from the rest of the property and cannot be economically recovered by a separate incline or shaft. The Local Government's attitude is evidently opposed to any general policy of conservation of good quality coal. It should therefore, we think, lease this coal and permit it to be recovered, even without stowing, so far as the Chief Inspector of Mines thinks will not prejudice the safety of the Road taking into consideration the thickness of the seam and the depth at which it lies. With stowing directed by our proposed Statutory Authority, all this coal should be recovered except what has already been lost for ever.

174. COAL UNDER RIVERS.—This is provided for adequately by Temporary Regulation 9 issued with Government of India Notification No. M955 of the 23rd May 1936. The extraction of coal under any part of the bed of a river, or under any spot within 50 feet from either bank, is never allowed now except under conditions laid down by the Chief Inspector, and partial or complete

stowing usually has to accompany pillar extraction or precede it to ensure stability.

175. COAL UNDER AGRICULTURAL LAND.—Sometimes the mine-owner has surface rights as well and pays a comparatively high rent for the land because of the probable damage to it. If not, compensation for agricultural land damaged or likely to be damaged by subsidence is usually arranged amicably between the mine-owner and the tenant concerned. As a general rule, such land becomes cultivable again, with perhaps some levelling, after the subsidence has settled. When the subsidence is deep or comparatively large in area, and often also in ordinary subsidences, the land is acquired by the mine-owner. This is comparatively easy in Bihar under the summary procedure laid down in section 50 of the Chota Nagpur Tenancy Act, and we recommend that section 84 of the Bengal Tenancy Act be amended so as to allow of the same procedure for the acquisition of a holding or any part thereof for the purpose of mining.

176. CONCLUSION.—It is impossible to estimate, even approximately, the recoverable coal locked up under surface features other than railways and the Grand Trunk Road. The quantity must, however, be very considerable, and practically all of it can be won without any risk with stowing. This should be attended to by our proposed Statutory Authority, compulsory stowing with assistance being first directed in those areas where the coal must be extracted immediately if it is not to be lost for ever.

CHAPTER VIII.

General Economic Considerations and their application to Indian Conditions.

177. Having reviewed all the relevant facts and figures in connection with methods of mining, organisation of the trade and industry, avoidable waste, collapses, fires and other accidents, and available resources, we shall now deal with some general economic considerations and apply them to Indian conditions before going on to suggest what measures of State control we consider necessary to meet the situation.

178. LAW OF DIMINISHING RETURNS.—The economic law of diminishing returns applies as generally to mines below ground as to agricultural land on the surface because the difficulties and costs of extraction increase as mines are developed at greater depths. So far as raising costs per ton of available coal are concerned, this arithmetical progression tends to become geometrical with wasteful methods due either to lack of experience or the lure of large profits. Such wasteful methods are found both during prosperity and during depression. When markets are favourable, coal is won quickly and without waiting for technically sound development. As one witness (W. No. 37) put it: "The plea now put forward is that the selling price of coal is too low to admit of introducing methods which will lead to improved and safer working, but it must not be forgotten that, when selling prices of coal were high, the same wasteful methods of working were pursued and profits were taken regardless of the future; in fact most of the danger already done to coal properties occurred when coal was in great demand and prices were abnormally high". Between 1914 and 1923, the number of coal-mines in India increased by 322 or about 50 per cent., while production rose from 16 to 20 million tons though export markets amounting to about $1\frac{1}{4}$ million tons were lost. Standards of quality fell because buyers were not particular, but the export markets were beginning to be lost even before the restrictions owing to competing foreign coals being of better quality and condition. Conversely, when times are bad, coal is won cheaply, raising costs are cut down ruthlessly, and, as some overhead charges go on whether a mine is worked or not, output often has to continue and is occasionally speeded up in order to reduce comparative costs and counterbalance low prices. The result is a vicious circle of over-production, cut-throat competition and uneconomic prices, such refinements as depreciation and depletion being more or less disregarded. In India, this circle is made more vicious, because, in the absence of combination, every producer has to try to under-sell his rivals by tendering at prices based on his potential output though his contract, if he gets one at all, is almost certain to cover only a portion of that output.

179. The inevitable action of the law of diminishing returns can be delayed if, as the more accessible seams are exhausted,

technique is improved so as to lessen avoidable waste, and if an optimum size of working unit is evolved with adequate capital and equipment, and under competent management and supervision. If technique does not advance or is subordinated to considerations of immediate profit, or if consolidation or amalgamation is not undertaken voluntarily, these desirable ends have to be achieved by external pressure, and State intervention then becomes necessary in the form of some statutory authority armed with powers to enforce its decisions.

180. MODERN ECONOMIC TRENDS.—Early writers pictured an "economic man" living in unfettered freedom and actuated by self-interest and hope of the largest gain with the least effort, but later economists visualise real men facing economic friction and influenced by mixed motives. Similarly, the emphasis of economic science itself has shifted from wealth to welfare, self-interest has been diverted into social channels, and many economists now believe that the State is the only authority strong enough to correct and control the mistakes of individual activity. The result has been a world-wide trend away from the competitive ideal towards formulas of public control. This development of State direction and control of trade and industry has been due also to the increasing interdependence of national and international economic systems, the emergence of problems, such as unemployment, which are beyond individual solution, and the realisation that trade cycles are not inevitable, but are caused by the selfish exploitation of favourable conditions. The doctrine of *laissez-faire* has been killed by the force of circumstances, and private property is no longer based on natural right, but on communal service and convenience. Hence arises rationalisation which is too serious a business to be entrusted to individuals, and must therefore be undertaken by the State in varying degrees of initiative, direction and supervision. The world position in this respect has been authoritatively summed up in one of the General Reports to the Third World Power Conference held at Washington in 1936. After stating that "the greatest of all economic depressions" hit coal mining particularly hard, world production in 1932 having declined by 28 per cent. as compared with 1929, and only recovered to a 15 per cent. lag in 1935, the Report goes on to say:—"One of the most striking features of the reports submitted to this Conference is the clear-cut evidence that unrestricted competition, as we knew it early in this century, has been generally abandoned so far as the coal industry is concerned. Nearly all countries apparently have found that an unregulated system of production brought results that were socially undesirable. Consequently, in all parts of the world, public control over the production and distribution of coal has been tightening".

181. DEVELOPMENT OF RATIONALISATION AND STATE CONTROL.—The World Economic Conference held at Geneva in 1928 defined rationalisation as "the methods of technique and of organisation designed to secure the minimum waste of either effort or material".

The underlying idea is that individuals cannot be allowed to pursue their own interests and inclinations at the expense of the community. Rationalisation aims at the control of economic life through the application of scientific methods and purposive direction to production, distribution and consumption. It therefore tries to eliminate the misdirection and miscalculation of individual competitors, and to co-ordinate the efforts of individual enterprise. It denies that industry is organized to enrich individuals at any cost to the community, and it relegates considerations of self-interest to a subordinate place. Personal initiative and personal gain are not excluded, but the main object is to increase national efficiency and national income by State control and supervision combined with better organisation and better methods.

182. It has been asserted that the case for rationalisation is particularly strong so far as coal mining is concerned. Coal is everywhere a national asset because it cannot be replaced once it has been removed, because it remains the main source of all mechanical power, and because it is still the basic requirement of the transport, iron and steel, engineering and other industries. Further, not only is the number of land and mineral owners large, but they are also apt to take varying views of their rights and responsibilities, and are besides often obstinately opposed to organised co-operation or mutual concession. Where, as in India, landlords do not usually arrange for expert advice, leases are given without regard to mining considerations; properties are thus leased out in uneconomical sizes and shapes, and without any enforceable provisions as to the methods by which they are to be worked. It is generally agreed now that there is a great difference in economy and efficiency in favour of large raising units. Then, much avoidable waste occurs in all countries owing to defective methods of production, distribution and consumption. Finally, coal mining is a dangerous occupation, and the safety of its workers must be secured to the fullest possible extent, while research on a national scale is continuously necessary into the problems of improved organisation, better methods and uses, fuel technology, and the safety of miner and mineral.

183. Position in Great Britain.—In Great Britain, it was recognised, even before the economic depression began in 1929, that some form of regulation was essential because the capacity to produce had outrun demand and competition had become disastrous alike to owners, workers and the public interest. Statutory effect was given to this feeling by the Coal Mines Act of 1930 (20 & 21 Geo. 5, Ch. 34), Part I of which provided for experimental district and central schemes regulating output and allocating quotas, fixing minimum prices based on raising costs, and dealing with reorganisation generally. These schemes were to be framed and administered by the industry, but had to be approved by the Board of Trade with primary reference to the public interest. As was very necessary in legislation of an experimental character,

power was given to amend such schemes, both in detail and structure, with the Board of Trade's approval. The legislation was not to remain in force beyond the end of 1932 unless Parliament decided otherwise, but it was extended till the end of 1937 by the Act of 1932 (22 & 23 Geo. 5, Ch. 29) and will almost certainly be continued for a further five years at least. Tonnage control has been more successful in practice than price control, but two central selling schemes were evolved in 1934 and other schemes for the general reorganisation of sales are being formulated. The difficulties of such rationalisation in Great Britain are greater than they would be in India because the seasonal and export demand for coal fluctuates, because production is not in the same hands as distribution, and because labour is comparatively enlightened and politically powerful.

184. In addition, the advantages of consolidating and amalgamating colliery interests have been recognised more and more. The Royal Commission of 1925 recommended a policy of grouping by voluntary action, and the Coal Mining Industry Act of 1926 (16 & 17 Geo., Ch. 28) gave effect to this recommendation by exempting the necessary transfer documents from stamp duty. Then came Part II of the Coal Mines Act of 1930 which set up a Coal Mines Reorganisation Commission " to further the reorganisation of the coal mining industry with a view to facilitating the production, supply and sale of coal by owners of coal mines, and for that purpose to promote and assist, by the preparation of schemes and otherwise, the amalgamation of undertakings consisting of or comprising coal mines where such amalgamations appear to the Commission to be in the national interest ". The original idea was to stimulate voluntary combinations and to keep the compulsory powers in the background, but gradually the necessity for utilising effectually the power to enforce amalgamations and absorptions has been established, and more definite powers are being considered with this end in view. The object is more economical and efficient working, and the practical basis of transactions is what would have been the value as between a willing buyer and a willing seller if the Act had not been passed. Valuation is said to depend in practice on expected average profit and supposed length of life. More recently, rationalisation has been used to remedy unemployment in the distressed areas of Great Britain by transferring those who cannot get work to areas where work is available and by setting up factories in parts where unemployment is most general. It is also proposed to unify and nationalise royalties.

185. Part III of the 1930 Act dealt with hours of work, and Part IV introduced a representative Coal Mines National Industrial Board with an independent Chairman appointed by the Board of Trade. The functions of this National Board are (i) to record agreements between owners and workers regarding wages or other conditions of labour, and (ii) to enquire into disputes on such points

referred to them by owners or workers after the latter have failed to settle matters between themselves.

186. POSITION IN GERMANY.—In Germany, rationalisation has proceeded further and is known as " socialisation ". The Reich controls the trade and industry and orders are issued by the Federal Minister of Economy. Free competition at one extreme, and State ownership at the other, have both been rejected as neither was expected to yield such good results as compulsory co-operation among private producers under State control. Mineral rights are legally separated from landownership, and the State has a right of reservation over the more important mineral resources including coal. Powerful combines are made compulsory, but are not allowed to profiteer. The Minister controls outputs, exports and imports, and regulates distribution and prices. In Great Britain, the control of output has been unified, but in Germany the whole trade and industry is one administrative unit. This State control in Germany has the following purposes according to the General Report to the Third World Power Conference referred to above:—

> " To protect the public welfare; to ensure the stability of the earth's surface in the interests of personal safety and that of public traffic; to care for the safety of workings as for the lives and health of the workers."

So far as conservation is concerned, there is comprehensive control with the declared object of extracting all available coal, stowing being consequently compulsory where necessary.

187. POSITION IN THE UNITED STATES OF AMERICA.—In the United States, though the reserves of bituminous coal and lignite amount to about three billion metric tons, the National Industrial Recovery Act of 1933 aimed at controlling and stabilizing prices, but was declared unconstitutional by the Supreme Court within two years of its enactment. It was followed by the Bituminous Coal Conservation Act of 1935, the declared purpose of which was conservation rather than stabilization, but this Act also was largely invalidated by the Supreme Court, and the industry is now practically without Federal regulation outside safety of life. The problem still remains, however, and President Roosevelt has made it clear recently that he has not abandoned his policy and is trying first to meet the deadlock by creating more and younger judges.

188. POSITION IN FRANCE.—In France, the coal industry has always been controlled on the lines stated in paragraph 34 of the 1920 Coalfields Committee's Report, and it has recently been announced that the present Government intends to nationalise the coal mines. As regards the coal trade, sales agencies were organised between 1928 and 1935, and these organisations have an internal sales agreement limiting areas of sale so as to restrict competition. This agreement is administered by a Government Department. Imports have been controlled by licenses and quotas for different countries.

189. Position in some other countries.—Japan introduced control over production and sales in 1934. Cartels are subsidised and unhealthy competition is eliminated. The Government supervises the cartels and the operations of the Coal Mining Union which controls production by assigning quotas, and of the Showa Coal Co. which ascertains market demand and fixes prices. For small collieries there is a similar, but separate, Mutual Aid Association.

190. In South Africa, the Transvaal Chamber of Mines representing all mining interests has controlled market organisations, regional sales, recruiting of labour and wages, etc., since 1907. There was no such organization in Natal till 1930 when two bodies were formed, the Natal Associated Collieries to control internal sales, and the Natal Coal Owners' Association to control bunker and export business. This is said to have eliminated price-cutting. The Government regulates mining methods and safety in mines. The railways are State-owned with specially low freights for exports and internal freights on a regional basis to ensure equal competition. Further, export and bunker coal is graded and no producer can participate in this trade without a grading certificate. The Fuel Research and Coal Bill of 1930 empowers the Government to prohibit or restrict export in emergencies, and to acquire coal for railways and certain administrations at reasonable prices. Fuel research is financed by a capital fund voted by Parliament *plus* an annual levy not exceeding $\frac{1}{8}$ of a penny per ton on collieries raising more than 25,000 tons, an amount equivalent to the proceeds of this levy being contributed by the State.

191. In Holland, Bulgaria and Czechoslovakia, the minerals are owned by the State, and State mines produce 60 per cent. of the annual output in Holland, 80 per cent. in Bulgaria and 10 per cent. in Czechoslovakia. Production and price are thus automatically controlled by the State in the first two countries; in Czechoslovakia, the Government is empowered to fix prices, while district trade organisations control competition among their members as regards output.

192. Rationalisation in India.—The objection usually made against rationalisation is that it limits private enterprise and that individual control is better than general co-ordination. As recently as 1926, the British Mining Association contended that " the theory that the industry can be coerced into prosperity by restrictive action from outside is unsound, and is foreign to the tradition of free and open competition on which the success of the British industry has been built up under private enterprise in the past " Speaking at the last annual meeting of the Bengal Chamber of Commerce on the 26th February 1937, the President is reported to have voiced much the same point of view:—" One of the big problems which is exercising the minds of all Governments and business men the world over is the proper relation of Government to commerce and industry. Under certain dictatorial forms of Government, we have seen Governments encroach upon business in directions and to a degree which is incompatible with our own

ideas of freedom. The functions of a Government, according to the tenets of the political and social systems to which we adhere, ought to be limited in times of peace, broadly, to securing sanctity of contracts and the fullest scope for the development of individual initiative and enterprise, placing on each individual only that degree of restraint which will prevent his encroachment upon the rights of others and, perhaps I might add, the permanent uneconomic employment of the country's irreplaceable assets ". This has always been the attitude against any innovations considered likely to affect profits. When the first Mines Act for India was proposed, the Indian Mining Association called a special meeting some time in 1894 to discuss the whole matter. One or two quotations from speeches made at this meeting will illustrate our point. They are taken, we may add, from Sir George Godfrey's speech at the annual dinner of the Mining and Geological Institute of India held on the 30th January 1931 (see Transactions, Vol. XXVI, page 35). One speaker said: " I fail to see how, from any point of view, we can possibly agree to a movement which will cause positive hardship to those it is intended to protect, which will increase the expenses of coal-getting by fully 50 per cent., and will, in similar proportion, add to the difficulties of all the industries in the Empire ". Another statement was: " We feel that an attack upon the coal industry of Bengal means an attack on every other industry of Bengal in which coal is used, and such being the case it is not to be wondered at that we are prepared to resist, with all our strength, any blow aimed at the Bengal coal industry ".

193. This old, but now obsolescent, attitude has been waived aside in Great Britain and will almost certainly meet with the same fate in this country. India already has a Factory Act, an Explosives Act, a Workmen's Compensation Act, a Payment of Wages Act, a Companies Act, and a Mines Act, all of which restrict freedom of contract and individual liberty of action, and are designed to secure various ends in the public interest. In the case of railways, the advantages of forming larger and more economic units has been accepted in practice in most parts of the world, and the Railway Board supplies an example in India of co-ordination and co-operation being substituted for individualism. We believe that State control of coal output and prices must come eventually in India unless there is a redical change in the psychology of the coal trade, while we are sure that there is considerable scope now for rationalising not only the various elements of the coal trade and industry, but also the aims and activities of landlords, mine-owners, railways, and the iron and steel and other industries. Railways, for instance, are the largest consumers of coal, but also derive most of their traffic from coal, and the interests of both could surely be reconciled into more harmonious co-operation. All this is not likely to be achieved, however, except by State agency, with the impressed help of the interests concerned, and should be an essential function of our proposed Statutory Authority after it has dealt with the more urgent problems of safety and conservation.

194. STATE CONTROL IN INDIA.—The case for State intervention in India to prevent avoidable waste and secure conservation of the available reserves was put by the 1920 Coalfields Committee as follows:—

> "Coal is a national asset on which the manufacturing industries and the commercial expansion of the country depend. A landowner or colliery proprietor is at present in a position to waste this national asset without restriction. By such waste he may obtain immediate financial benefit, but he injures the country, damages his property and diminishes the estate of his heirs. We hold that the State has the right, in the interests of the community, to step in and prevent the dissipation of the country's resources. Indian coal is not inexhaustible and scientific mining methods are needed for its conservation and economic extraction."

Speaking at the annual dinner of the Mining and Geological Institute of India on the 15th January 1937, His Excellency Sir James Sifton, Governor of Bihar, said:—"I feel sure that most of you will agree that there was an initial mistake; that the coal of a country is a national asset, that it ought to be protected by Government from wasteful exploitation for ephemeral profit, and that the *laissez-faire* policy applied to irreplaceable national wealth is exploded and out-of-date". It is clear that, since 1920, the case for State control has become very much stronger because the proportion of coal now being won from pillars is so much greater, because the waste, damage and danger during pillar extraction are all very much larger than during first working, because the alarmingly limited extent of Indian reserves of coal of good quality has been established scientifically, and because the coal trade and industry is now in a parlous plight from which there seems to be no hope of extrication by its own efforts. It has thus become the duty of Government as representing the existing community, and as trustees for posterity, to step in and impose some definite line of action upon a trade and industry which has not done much to help itself as a whole, and which shows little disposition to help itself in future. The potential strength, and consequently the political importance, of every country is dependent largely on its industrial organisation. Yet, in India, the healthy growth of this organisation is being endangered by senseless rivalry and suicidal competition among those who are responsible for the recovery of the raw material on which all industrial organisation rests. It is admitted that coal is being wasted, but it is argued that this is unavoidable under market conditions which no one does anything to improve. As one witty observer has said, mine-owners have been rather like greedy boys in an orchard biting out the sunny side of their apples and throwing the rest away. Apples can be replaced, however, while coal cannot. Yet, though it is undeniable that the available resources of coal are approaching exhaustion within a period which is relatively short as compared with the probable industrial life of the country, it is contended

that the immediate gain of a comparatively few people is more important than any ultimate advantage to the life and productivity of their collieries and to the country as a whole. Another argument admits the comparatively limited reserves of good coal, but points to the possibility that, long before those reserves are exhausted, coal may be superseded by oil, hydro-electricity or some undiscovered source of energy. Apart from the answer that no country of any importance can stake its future on such possibilities, and apart also from the fact that the life of the world's oil resources is much shorter than that of India's resources of good quality coal, it can be argued with equal cogency that the uses of coal may be considerably extended in the near future by such developments as hyrogenation, low temperature carbonisation and colloidal fuel. It is perhaps natural that those who are responsible for waste by methods of exploitation based mainly on considerations of profit and loss should object to any interference with their freedom of action, but this attitude is contrary to public interest, and will, we have no doubt, be strongly condemned by the community at large. The general demand will almost certainly be that good coal must be conserved and avoidable waste prevented so far as is possible. There is little or no hope of really effective help from the coal trade which is not only riddled with jealousy and suspicion of rivals, but is also rent by two main cleavages, one between Europeans and Indians, based mainly on the size of the properties controlled by each, and the other between Indian owners represented respectively by the Indian Mining Federation and the Indian Colliery Owners' Association. We have seen that these two Associations, together with the Indian Mining Association representing European interests, have declined to reply to our questionnaire or to send witnesses for oral examination, one of their common grounds being that there was no prospect of unanimity among their respective members. Some firms in the trade keep out of minimum price agreements or will only join them on conditions favourable to themselves; other firms have been known to accept the terms and then break them by tendering at prices lower than the agreed-on minimum. Again, many firms have special advantages in the quality of their coal or the comparative cheapness of their costs, and will not surrender any of these advantages in the general interest. It was, we believe, once suggested that all buying and selling of coal should be entrusted to a certain big firm which produces coal for its own use, but does not compete in the open market. This constructive idea was rejected because that firm is known to work reciprocally with other firms in other lines of business, and could not therefore be trusted to refrain from giving its business friends preferential treatment in allocating orders.

195. STATE CONTROL IN THE COAL GRADING BOARD.—When the Coal Grading Board was first constituted in 1926, the intention was that the Chief Mining Engineer to the Railway Board and the officers of his Department should give coal grading a start and

only be responsible for its working for two years, the idea being that grading and inspection for export should thereafter be done by independent officers employed by the Grading Board. Speaking in the Legislative Assembly on the 3rd September 1925, the Hon'ble Sir Charles Innes said:—

> "We do not intend—certainly I can speak on behalf of the Railway Board and the Government. We have no desire that the Chief Mining Engineer to the Railway Board should prepetually run the coal grading for the Railway Board. We hope in a very short time the coal trade will take over the work itself. But if they do not shown signs of doing so within a comparatively short time, we shall take steps to stir them up in the matter."

Eleven years have since passed and the Chief Mining Engineer's Department is still in charge because it is admitted that the coal trade cannot do the work as cheaply nor with the same efficiency and disinterestedness.

196. Railway Collieries and State Competition.—The coal trade and industry still complains vociferously against competition from the State and Company-managed railway collieries, the closing down of which would, it is said, restore prosperity magically. Though the rights and wrongs of this subject are not within our terms of reference, and no final opinion can be given regarding it without a detailed examination of all the factors involved, we may point out that consumer-owned collieries are common in all countries, and that it makes no difference in principle or practice whether the consumer is an industrial corporation, a public utility concern, or a railway company. It may be that the average costs of raising "captive" coal from consumer-owned mines are higher than in commercial mines where the pressure of competition compels stricter economy, but this is the concern of each such consumer who must necessarily be limited by the selling price of his own product, and can accommodate output to the rise and fall of the market. In India, the coal trade and industry does not and cannot object to iron and steel companies, steamer companies, and other industrial organizations owning and working collieries, and our information is that all these consumers have been compelled to acquire collieries to protect their legitimate interests against unjustifiably high prices and to ensure continuity of supply when for any reason, such as shortage of labour or wagons, sufficient coal cannot be readily obtained in the open market. Speaking in the Legislative Assembly on the 3rd September 1925, the Hon'ble Sir Charles Innes asked: "Is he (*viz.*, Sir Willoughby Carey) satisfied that the Indian coal trade is entirely guiltless in this matter, and will he not admit that it was the way in which we were squeezed, and that the prices charged to us for coal in 1920 and 1921 was one of the reasons that compelled us to go in for this method in order to protest ourselves?" Sir Charles went on to say that, in 1923, the Giridih Railway Colliery was raising coal at

less than Rs. 5 a ton, while the coal owners were charging the railways Rs. 8 to Rs. 11-12 a ton. Very recently, shortage of labour following good crops, and accentuated to some extent in the Raniganj Field by the Poidih disaster, caused a serious dimunition in supplies of coal; prices went up and certain railways would have been seriously embarrased, and might have been compelled to suspend some of their services, had coal not been obtained by increasing output from the Railway Quarries at Bokaro by about 60 per cent. All losses on the working of State-owned railways must fall on the general tax-payer, and there seems to be no reason why the latter should be mulcted in order to benefit the coal trade and industry. Further, if a State colliery like Giridih were shut down, it is more than probable that most of the 10 million tons of recoverable coal left there would be lost entirely. It seems to us therefore that all that can reasonably be expected has been done by the State Railways agreeing to purchase two-thirds of their coal requirements from the collieries of limited companies and private owners. This in itself involves restricted outputs and proportionately higher raising costs. It would, however, further assist the coal trade and industry if a similar limitation could be applied to the purchases of those Company-managed railways which arrange for their coal requirements through the Chief Mining Engineer to the Railway Board.

197. In this general connection, it is necessary to refer here to a contract between the Railway Board and the Bengal Iron and Steel Company which has been brought forcibly to our notice. It does not perhaps concern us directly, but it is relevant to the general question of competition between State and private products so far as coal is concerned. This contract has been made for a period of three years from about June 1936, and provides for the supply of the entire quantity of hard coke produced at the Giridih State Colliery less the amount (roughly estimated at 25,000 tons of the best quality) required for railways. The Company will get about 50,000 tons a year at Rs. 6-4 per ton f.o.r. Kulti. This price was arranged by the Railway Board and, according to the Chief Mining Engineer (W. No. 37) one of the considerations that determined it was the fact that the Bengal Iron and Steel Company can manufacture hard coke out of slack from their own collieries at a lower cost. It is said also that the hard coke at Giridih is manufactured from slack which would otherwise be surplus and could not be disposed of. It still remains true, however, that Messrs. Tata, buy hard coke from the private hard coke manufacturers at Rs. 7 a ton f.o.r. coke plant, while the railway freight from the Jharia Field to Kulti is Rs. 1-1 a ton. The lowest price at which private manufacturers can supply at Kulti is therefore Rs. 8-1 a ton as compared with Rs. 6-4 per ton in the contract referred to. It would appear therefore, more especially as Giridih coking coal is the best in India, that this contract is contrary to the general policy of Government that the productions of Government Departments should not compete with private enterprise

except within unavoidable limits (*e.g.*, the disposal of production in excess of State requirements without loss) and upon equal terms in every respect.

198. CONCLUSION.—In all the circumstances described above, we are definitely of opinion that State initiative and State intervention constitute the only effective remedy and are already overdue.

CHAPTER IX.

Control over Working Methods.

199. STATE CONTROL IN INDIA.—At the Mining and Geological Institute dinner on the 15th January 1937, His Excellency the Governor of Bihar said that " the pitiful part of the history of the coalfields is the absence in the past of Government intervention and the aloofness of Government from the problem of getting the best out of the mineral wealth of the country ". This frank admission of the inactivity of the State is in accordance with facts. Ever since Mr. Treharne Rees and the Coalfields Committee reported in 1919 and 1920 respectively, it has been known that damage was being done to the country's coal resources, and danger being created to life and property, by the defective working methods permitted by the mineral owners and followed by the mineral lessees. Since then, various difficulties and dangers have been met as they arose by various Acts and Regulations, but there has been no attempt to deal comprehensively with the whole problem, and the consequences have been equally injurious to the coal trade and industry and to the interests of the community in coal as a national asset. In letter No. M76-140 of the 23rd May 1921 dealing provisionally with the 1920 Coalfields Committee's Report, the Government of India said that " the Committee's proposals involve, in some instances, a very considerable departure from the previous conditions under which, provided the safety of workers were properly ensured, the colliery interests were at liberty to extract their coal by whatever methods were permitted under their leases, however wasteful ". As no action was taken on the proposals referred to, the result was to confirm mine-owners in the conviction that they could do as they pleased with their property and extract coal by any methods which did not jeopardise human life at the moment; as little or nothing was done to enforce the terms of their leases, there were no practical restrictions in this direction. Hence has arisen the idea that the State cannot interfere with private rights even though it is merely a topographical accident that the minerals in Bengal and Bihar do not belong to the State as they do in the Central Provinces. Statutory control over the coal trade and industry already exists in the Indian Mines Act, and we have shown that every other important coal-producing country in the civilised world has taken measures in recent years to control that trade and industry in various ways and to varying degrees. The amount of State control necessary in any particular country must depend on the nature and urgency of the situation, and we are definitely of opinion that the situation in India demands as much control as is possible without nationalising the mines or the royalty rights. There are some who argue that, though more State control may be required, it should be confined to outputs and prices, the suggestion being that better prices for smaller outputs would lead to improved methods being adopted without any State compulsion or control. As the Government of India pointed out, however, in rejecting the trade's Coal

Restriction Scheme in 1935, wasteful and dangerous methods were not stopped when coal prices were high during the boom periods. " If ", the Government went on to say, " action for conservation of coal supplies is necessary, there is, in the view of the Government of India, only one effective method of securing it, and this is to attack the evil directly by controlling the methods of coal production, and so to ensure that improved methods are adopted where they are most needed ".

200. EXISTING STATE CONTROL.—Until the temporary legislation and regulations of 1936, the law restricted State control to safety of life without any provision for safety of property. Even as regards safety of life, the powers of the Mines Department were more protective than preventive. Section 19 (1) of the Indian Mines Act of 1923 enabled the Mines Department to require a matter, thing or practice to be remedied provided it " *is* dangerous to human life or safety " or so defective " as *to threaten, or tend to,* bodily injury of any person ". If any such order was contravened, the delinquent could be prosecuted and fined under section 39 or, if the contravention resulted in loss of life, or serious bodily injury, or injury or danger, to workers or other persons in or about the mine, prosecution with imprisonment or fine, or both, could follow under section 40. The only effective remedy was, however, contained in section 19 (2) under which the employment of labour could be prohibited until the danger to life or safety was remedied provided that danger was *urgent and immediate.* It is evident therefore that section 19 (as it stood before the Amending Act of 1936) read with section 6 defining the powers of the Chief Inspector and Inspectors, not only confined interference by the Mines Department to circumstances affecting human life or safety, but also limited such interference to conditions in which danger was actually present. There could be no interference to prevent potentially dangerous conditions developing into actual danger. The powers were therefore about as effective for preventive purposes as the powers of a magistrate to prevent a breach of the peace under section 144 of the Criminal Procedure Code would be if he could only exercise those powers after a breach of the peace has occurred. So far as coal mines are concerned, it is evident that the danger had as a rule been created or the damage done before the powers of the Mines Department could be effectively used, and in any event action to prevent loss of life was usually too late to prevent loss of coal.

201. Then came the amending Act of 1936 followed by several Temporary and Supplementary Regulations. For the first time, section 19 (1-A) empowered interference (i) as regards depillaring operations *likely to cause* the crushing of pillars or the premature collapse of *any part of the workings* or *otherwise endanger the mine,* and (ii) as regards adequate precautions against outbreaks of fire where depillaring *is contemplated* or in an area that *might be affected by a fire.* Further, section 29 (*p*) allowed the extraction of minerals to be restricted or regulated in circumstances *likely to result in or aggravate* explosions or ignitions and irruptions or accumulations of water, while section 31-A authorised the issue of

regulations, without previous publication and without previous reference to Mining Boards, for the prevention of *apprehended danger* or the speedy remedy of conditions *likely to cause danger*. So far as the safety of property is concerned, section 19 (1-A) (*b*) made almost the first step in this direction (the only previous reference to " the safety of the mine " being in Regulation 146) by authorising the Mines Department to limit the dimensions of galleries driven in a mine. All this marked a great advance, but the amendments to the Act, and the Temporary and Supplementary Regulations issued under those amendments, will only remain in force for two years from the 16th May 1936 unless they are permanently enacted meanwhile. The new legislation was at first applied to the Jharia Field only, but was extended to the Raniganj Field in December 1936.

202. The actual necessity for these powers has been amply demonstrated by the fact that, during 1936 and up to the 20th February 1937, the Chief Inspector of Mines issued 42 orders under section 19 (1), 81 orders under section 19 (2) and 50 under section 19 (1-A) without any appeals being preferred against these orders under section 19 (5). In his evidence, the Chief Inspector (W. No. 36) has told that, during the first six months that section 19 (1-A) was in force in the Jharia Field only, orders under that section were issued to no less than 35 collieries. The action taken in 1936 has often been referred to as " panic legislation ", but practically every witness who appeared before us has agreed that the temporary legislation and regulations should be made permanent. Some have advocated that the powers thus conferred should be extended to compulsory stowing for safety and conservation, general principles of first working, precautions during pillar extraction, section-working, rotation of working, and working under or near fire areas.

203. GENERAL PRINCIPLES OF FIRST WORKING.—The extent to which the law and regulations now in force require to be strengthened as well may be considered with reference to (i) first or whole working, and (ii) pillar extraction or broken working. Unsound first working is a kind of overdraft on future production because subsequent working is made more difficult and dangerous and also more costly in money and life. The evidence given before us on this point (see the answers to *Questions 19 and 20* of the general questionnaire) is interesting and should be studied. Of the 44 technical witnesses from Raniganj and Jharia, 36 were finally in favour of general principles of first working being laid down by regulation. Out of this number, no less than 20 were originally against the idea of fixing the dimensions of pillars and galleries, but changed their opinions after examination by the Committee. Of the 8 witnesses whose evidence, as it stands, is against such general principles, 7 were not examined orally at all, and there is every reason for thinking that they would have also changed their opinions after discussion with us. It can therefore be asserted that expert opinion is overwhelmingly in favour of general principles of first working being laid down by regulation, some witnesses being

convinced that such general principles are essential if mining methods are to be improved generally.

204. The original objections were based on the following grounds:—

(i) that the conditions vary too much from mine to mine, and from seam to seam, to make any such principles practicable;

(ii) that such principles would interfere unjustifiably with the rights of owners and with the initiative and discretion of managers; and

(iii) that sub-section (*b*) to section 19 (1-A) already gives the Chief Inspector power to fix the dimensions of galleries.

As regards the last point, apart from the fact that section 19 (1-A) (*b*) refers only to dimensions of galleries and says nothing about dimensions of pillars, we are definitely of opinion that this is not the proper method of handling the problem. As it stands, section 19 (1-A) (*b*) necessitates the passing of a potentially vast number of special orders because every seam in every mine may have to be dealt with, and because modifications of the original orders would become necessary as the depth of the workings increased. We think therefore that the best procedure is to frame a regulation covering the large majority of cases leaving only the unusual ones to be dealt with by special orders. Any other procedure would tend to transfer to the Mines Department the responsibility for control, direction and management that is now vested in the managers by section 15 of the Mines Act.

205. As regards the first two objections, most of our witnesses withdrew them on being told that the principles contemplated would allow for differences in depth from the surface, that the Mines Department would be empowered to vary those principles either way to suit special circumstances and local conditions, and that an appeal would be allowed from adverse decisions of the Mines Department regarding such variations to the same authority as hears appeals under section 19 of the Act. It was also pointed out that managers who were using sound methods would probably not be interefered with in practice, but that there were even now, in spite of the advance in mining knowledge and experience, many mines that were being developed with unsound sizes of pillars and galleries, and that it would therefore be a definite advantage to sound workers to know that their neighbours all round were being required to work soundly as well. It is generally admitted in this connection that the greed, incompetence or thoughtlessness of some mine-owners has added appreciably to the difficulties, dangers and obligations of others. Another consideration that appealed to some witnesses is that the position of managers would be considerably strengthened against unscrupulous owners if they could point out that certain malpractices would produce illegal results for which they could not accept responsibility. The eventual result was that the weight of evidence turned definitely in favour of general principles of first

working being prescribed by regulation, and we are in entire agreement with this view. It is probable indeed that, even from a purely commercial point of view, such principles will be a gain rather than a hardship. As the Chief Inspector of Mines (W. No. 36) puts it:—" Much of the price-cutting that has brought down the prices of coal may have been due to less scrupulous owners robbing pillars while others continued to practise sound methods of working."

206. As regards the particular principles that should be prescribed, we have considered carefully various alternatives. One possible basis of such general principles would be fixed dimensions of galleries and pillars, the dimensions of the pillars being increased with depth. The objection to this is that such exact dimensions would deprive the management of initiative and latitude in laying out workings. Another general principle suggested was based on percentage of extraction. The objection to this is that, in a thick seam, an unscrupulous manager could make galleries of small height and excessive width in one section of the seam containing the best quality coal; another objection would be the opposite extreme of being able to make very narrow galleries of a height equal to the full thickness of the seam. A third principle considered was to require by regulation the submission of a plan showing the proposed lay-out of a mine for previous approval. The objection to this is that the authority dealing with such proposals would have to examine and approve plans for every seam of every mine, and also to examine and approve of all proposed variations from the sanctioned lay-out, such variations being often necessary as unexpected conditions are encountered in the course of development.

207. A fourth principle is the one which was originally proposed by a member of the Committee and has been accepted by the majority of the technical witnesses examined. This principle, which would apply only to mines in which the ordinary pillar and stall method was being followed, is based on percentage of the floor area of the seam to be left in pillars with a limiting average height and width of galleries. As regards height of galleries, we have adopted the " earnest " suggestion of the Second Subsidence Committee that " in all future workings no ordinary galleries should exceed 10 feet in height until immediately preceding pillar extraction ". As regards the width of galleries, we have suggested a maximum of 16 feet to allow for the use of coal-cutting machines. A Table showing the suggested percentages and dimensions at varying depths will be found below. The Chief Inspector of Mines would be given power in the regulation to extend or restrict the limits prescribed, either on application to him or on his own motion, according to the local conditions or special methods of working. Any orders of the Chief Inspector varying, or refusing to vary, the prescribed limits would be subject to appeal to the same authority as hears appeals under section 19 of the Act. The advantages of such general principles are that the manager can still use his discretion as to the width of gallery within the prescribed limits provided the floor area of the pillars is commensurate with that

width. A further advantage is that a manager who makes galleries of dimensions smaller, or pillars of dimensions larger, than those prescribed would be able to enlarge the galleries subsequently within the prescribed limits in order to maintain output.

208. It is very important that, if such general principles of working are laid down, the penalty for infringing them should be adequate and immediately enforceable. In order to secure this, the regulation should give the Chief Inspector or the Inspectors in charge of the Circle power, where he considers this necessary, not only to require measures of restoration or protection in order to ensure stability, but also to prohibit further coal-getting in the district concerned until his orders had been carried out. I would thus be possible to penalise owners where the departure from the prescribed limits appeared to be deliberate and actuated by considerations of profit.

Table for First or Whole Working.

Depth of seam from surface.	Percentage of floor area to be left in pillars.	Galleries 8′ average width. Pillar centres.	Galleries 10′ average width. Pillar centres.	Galleries 12′ average width. Pillar centres.	Galleries 14′ average width. Pillar centres.	Galleries 16′ average width. Pillar centres.
Ft.		Ft.	Ft.	Ft.	Ft.	Ft.
0—100	53	30	37	45	52	59
100—200	56	32	40	48	56	64
200—300	59	35	44	52	61	69
300—400	62	38	47	56	66	75
400—500	65	42	52	62	72	82
500—600	68	46	57	67	80	92
600—700	71	51	64	76	89	102
700—800	74	57	72	86	100	114
800—900	77	66	82	98	115	131
900—1,000	80	75	94	113	132	150
1,000—1,100	83	89	112	135	158	181
1,100—1,200	85	102	128	154	180	206
1,200 and greater depths.	85	102	128	154	180	206

Galleries must not exceed 10 feet in average height or 16 feet in average width. Where it is not the intention to make square pillars, the floor area of the pillars should be equal to the dimensions given in the above Table, but pillars shall not normally be of extreme or irregular shapes.

209. SIMILAR PRINCIPLES IN SECTION-WORKING.—The above general principles will apply to seams which are to be worked in one section, but it is also necessary to consider what general principles should be laid down in the case of seams which it is intended to work in more than one section. The consensus of opinion among our witnesses is that conditions and circumstances vary so much in different seams, and even in different parts of the same seam, that no general principles of section-working can be laid down by regulation. There can be no doubt, however, that the greatest care is necessary in such working and that it creates great difficulties and dangers if not properly done. Some considerations that have been suggested or have occurred to us in this connection are:—

(i) that the general principles of first working suggested already should apply to each section,

(ii) that working in too many sections should not be permitted,

(iii) that the galleries and pillars in each section should be vertically coincident, and

(iv) that the parting between sections should be at least equal to the height of the gallery in the upper section.

On the whole, however, we think that the best plan will be to prescribe by regulation that the lay-out of projected workings of all seams which are being worked, or are about to be worked, in more than one section should be submitted to the Statutory Authority for approval before any coal-getting is done. Such control of section-working would be primarily in the interests of conservation, and we think therefore that the Statutory Authority should decide each case with reference to the particular conditions and circumstances. Among other things, the Statutory Authority would have to consider a complete section of the seam so far as quality, stone bands, etc., are concerned, and then determine not only in what sections the seam should be worked, but also the order in which various sections should be worked and the arrangements which should be made to recover the largest possible percentage of the coal *in situ*. As we shall propose that the Chief Inspector of Mines be a member of the Statutory Authority, any objections that he may have to any proposed lay-out on the ground of safety will thus receive due consideration before any orders are passed.

210. The proposed principles of first working and section-working would continue in force until immediately before systematic depillaring operations. In order to prevent the splitting or robbing of pillars, and the heightening or widening of galleries, under the pretence that depillaring is about to be undertaken, it must also be laid down by regulation that no departure from the prescribed general principles (except of course with the previous permission of the Mines Department) would be allowed more than two pillars' length ahead of the pillar that is being extracted or from the point at which pillar extraction is about to begin. The regulation should also provide that, on giving one week's notice of intention to the Chief Inspector of Mines, the manager would be able to split

pillars or increase the dimensions of galleries for specific purposes other than coal-getting, such as haulage, ventilation, drainage or fault-cutting.

211. CONTROL OVER DEPILLARING.—Principles of first working will safeguard the future so far as undeveloped or partially-developed properties are concerned, but, in mines where the Statutory Authority cannot or does not direct stowing at first, control over depillaring operations will also be essential not only to prevent conditions becoming worse than they are now, but also to make compulsory stowing easier and less expensive when it comes to be done. Section 19 (1-A) of the Mines Act empowers the Chief Inspector of Mines to prohibit the extraction of pillars under certain conditions. This power should remain with him for special cases, but we think that, as the Statutory Authority will have to weigh the balance of advantage in each case between compulsory stowing with assistance and control without stowing, the future control over normal depillaring operations should be one of the functions of the Statutory Authority. As the Chief Inspector of Mines will be on the Statutory Authority, there will be no fear of any orders passed by the Statutory Authority in this connection resulting in increased danger to human life or safety.

212. The procedure we suggest is that mine-owners should be required to submit accurate plans of proposed depillaring operations to the Statutory Authority. These plans should show, or be accompanied by information regarding, the area or district to be depillared, the thickness of the seam and its depth from the surface, all faults and dykes in the neighbourhood, the proposed method and order of extraction, the dimensions of barriers or rows of pillars to be left as a safeguard against premature collapses and fires, the arrangements for immediate and efficient isolation if necessary, the fire areas near the proposed depillaring area either in the same or adjacent seams, the parting between the proposed area and the seams immediately above and below, and the state of the workings in those seams, and any other information that the Statutory Authority may require by general or special order. In considering such plans, the Statutory Authority would have power (i) to decide when, where and how the pillars should be got, (ii) to forbid the extension of an area under pillars pending arrangements for assisted stowing, where such extension appears likely to lead to unnecessary loss of coal of commercial or industrial value, and (iii) to order the isolation of workings. If, after the depillaring operations had been approved and started, any unexpected developments were reported by the Mines Department, the Statutory Authority would have the power to modify its previous decision in order to meet the new situation. Special care will be necessary in dealing with very steeply-inclined seams and areas in the neighbourhood of faults or dykes.

213. CONTROL OVER ROTATION OF WORKING.—The necessity for control over rotation of working is established by the fact that, in one part of the Raniganj Field, the Koithi seam, which is of

grade I quality in at least an 8-foot section, has in several collieries been destroyed or damaged by the depillaring below it of the Poniati seam which is of selected grade throughout. In one such case, the royalty-receiver made a claim against the mine-owner, and the matter was compromised by the mine-owner paying compensation and an additional royalty on the coal that was being recovered from the Poniati seam. In this case, the landlord was compensated to some extent over the loss caused to him, but very large avoidable waste of good coal occurred and was definitely prejudicial to national interests. In another case, the mine-owner has for years been damaging or destroying the Koithi seam above by depillaring in the Poniati seam below. In this case, the landlord took up the matter, but was apparently satisfied by the unsupported assertion of the mine-owner that the quality of the coal in the whole of the Koithi seam was very poor and unmarketable under conditions existing at the time. We are therefore definitely of opinion that rotation of working of seams must be controlled and that such control must, in some instances, involve prevention. As this control will be in the interests of conservation, it should be exercised by the Statutory Authority.

214. CONTROL OVER ACCUMULATIONS OF GAS IN GOAVES.—Of the 43 technical witnesses who submitted written evidence on *Question No. 16* of our general questionnaire, 28 admitted that, during the extraction of pillars in seams which give off inflammable gas, there was always a danger of accumulations of such gas in the goaves being expelled into the workings by falls of roof, and agreed that stowing was the most satisfactory method of dealing with this danger. Fifteen disagreed in their written replies with the suggestion that stowing should be enforced in such circumstances, but of these six agreed to compulsory enforcement on oral examination, while two others agreed provided adequate assistance is given to make the operation an economic one; of the remainder, 3 were not orally examined, and only 4 maintained in oral examination that the enforcement of stowing in the circumstances was not necessary.

215. When the extraction of pillars takes place in a gassy seam, cavities are formed when the local roof collapses and these cavities constitute traps for accumulation of inflammable gas. When a more extensive fall of roof occurs, this gas is forced out into the workings and may bring about a situation of great danger. It is practically impossible to examine these roof cavities for inflammable gas as it is difficult to get up high enough to test and it is often also dangerous to do so. Nor is it practicable so to ventilate such cavities that the gas is diluted and dispersed as it gathers. The following accidents have actually occurred owing to the conditions described above:—

(i) At the Dishergarh Colliery (Dishergarh seam) there was an explosion in the goaf in 1916 in which 18 persons were burnt of whom 14 died. The gas was expelled by a fall in the goaf, naked lights being used at the time.

(ii) At the Dishergarh Colliery (Dishergarh seam) gas was ignited in a goaf by a naked light in 1918, 14 persons being injured of whom 10 died.

(iii) At the Aldih Colliery (Dishergarh seam) gas was expelled from a goaf in 1933 and ignited by a naked light. Three persons were killed and six injured.

In addition there have been recent cases both in the Raniganj and Jharia Fields where gas has been driven out into the working places and safety lamps have been extinguished. Finally, it seems quite probable that the Poidih disaster of December 1936 was caused in this way.

216. There are certain seams in the Jharia and Raniganj Fields which give off large quantities of inflammable gas and in which safety lamps have to be used. There are also seams in which safety lamps are required to be used, but in which the quantity of inflammable gas given off is comparatively small. In such cases as the Dishergarh and Murilidih-Bhatdih seams, the usual precautions against inflammable gas are insufficient once the extraction of pillars is commenced. In the majority of seams in which safety lamps are required to be used, the quantity of inflammable gas is small and, in some, only slight traces of gas are occasionally found. In these cases, the danger is not grave and can be guarded against by ordinary precautions.

217. The thickness of the seam has a bearing on the subject because, in seams less than 8 feet or 10 feet thick, the goaf cavity is not so high and extensive as in the thicker seams, while the goaf debris soon prevents such falls occurring as would be likely to expel the gas. The depth of the seam from the surface has also a definite bearing because, when pillars near the outcrop of a seam are extracted, any gas in the goaf is readily released through open cracks or breaks to the surface, and as long as the thickness of strata between the seam and the surface is insufficient to prevent such open cracks or breaks up to the surface, the enforcement of stowing is not necessary.

218. It appears therefore that each case will have to be judged on its merits. The Chief Inspector of Mines will be the authority, as at present, to prevent the extraction of pillars in gassy seams under section 19 (1-A) except in conjunction with stowing. When he passed such an order, the ordinary procedure would be for the mine-owner concerned to apply to the Statutory Authority for financial assistance in connection with compulsory stowing. The Statutory Authority would then make the necessary arrangements and lay down also the manner in which stowing should be done including the protection of old goaves.

219. Some witnesses suggested that the use of electric safety lamps instead of flame safety lamps would reduce the danger. We agree that electric safety lamps would tend towards safety because the illiterate miners of India do not understand the proper care and use of flame safety lamps, but we do not consider this measure

a sufficient remedy by itself. We are of opinion that electric safety lamps are the next best protective to stowing, but it should be remembered that the gas expelled may also be ignited in other ways. One witness (W. No. 38) cited an English case where an explosion occurred in a mine when no one was underground and there was no underground fire. It was believed that the explosion was caused by sparks from a stone falling from the roof and igniting the gas. The same witness also cited the explosion at the West Stanley Colliery in England which was believed to have been due to sparks resulting from haulage ropes rubbing on spindles of pulleys or to tubs rubbing on the guide skirting rails at a high speed. We also know of a case in an Indian mine where gas was ignited by a spark from a miner's pick. As long as gas is present, the danger is always there and an explosion may occur at any moment owing to carelessness or negligence or circumstances beyond human control. The best plan therefore is to eliminate the chance of gas accumulating in goaves and this can only be done by compulsory stowing with financial assistance.

CHAPTER X.

Stowing in all its aspects.

220. STOWING DESCRIBED.—Stowing, packing, or filling up the space previously occupied by coal, was first used in America about 1892 to avoid extensive and expensive damage to surface and buildings. It was introduced into India at Ballarpur in the Central Provinces about 1914, and came to the Jharia Field about 1919. One of our members (Mr. Mackie) has more practical experience of stowing than any other mining engineer, and in 1929 described the results of sand-stowing operations at one of his collieries in the following terms:—

> "The area of the thick seam at Bhowra contained two million tons of coal standing in pillars (some of which are now 25 years old) and it was evident that without stowing it was not possible to recover much more than 25 per cent. of the available coal. During the ten years, production has continued steadily, showing a loss of about 2 per cent. of the coal with a minimum of danger to the workmen. Had the ordinary method of pillar-cutting in this thick seam been followed, it is safe to say that it would have resulted in the abandonment of the area ere this with a disastrous record of accidents, subsidence and underground fires, and with the loss of large quantities of valuable coal. Instead of which it is confidently hoped to continue extraction for at least 20 years without fear of fires or collapses."

Stowing does away with most of the dangers from premature collapses, subsidences, fires, inundations and explosions, ensures the maximum percentage of recovery without waste or loss of other unworked coal, and makes working conditions generally much safer for the miner. In addition, coal-getting operations are more concentrated, haulage and traffic simplified, and ventilation improved. The main objection to stowing is not technical nor practical, but economic, the additional cost being such that, even if a mine-owner can raise his coal profitably by distributing the cost or making up some of it by accompanying savings, he would still be at a competitive disadvantage with other mine-owners who did not or need not stow. Stowing has been done voluntarily, and is now being so done, in a few collieries near rivers, but its general adoption as a measure of conservation cannot be achieved, nor even reasonably expected, without State measures of compulsion equalising the economic burden as far as possible.

221. Stowing may be done by hand or it may be hydraulic, mechanical or pneumatic. Dry packing by hand is less expensive because no water has to be pumped back to the surface, but it is comparatively slow and only suitable for small operations. Pneumatic packing is also a dry method in which compressed air is used, but it is expensive, and only suitable in deep mines where the

cost of pumping would be high, and in mines where an adequate supply of water is not available all the year round. As regards packing materials, ashes, debris and crushed surface soil have all been used, but the best material is sand which does not have to be crushed and is subject to very little compression after settling. As sufficient supplies of water and sand are usually available, hydraulic sand-stowing is the most suitable method in the coalfields of India more especially as the gradients of the seams are for the most part favourable.

222. SUPPLIES OF SAND.—The coalfields of Bengal and Bihar are well served by the Damodar, Barakar and Adjai Rivers with large supplies of sand. Enquiries have been made at various times regarding the sand deposits in these rivers, the results of which will be found:—

(i) As regards the Jharia Field, at pages 106 to 108 of Dr. Fox's report in Volume LVI of the Memoirs of the Geological Survey of India.

(ii) As regards the Raniganj Field, at pages 298 to 302 of Mr. E. R. Gee's report in Volume LXI of the Memoirs of the Geological Survey of India.

(iii) As regards the Karanpura and Bokaro Fields, in Mr. G. V. Hobson's paper at pages 324 to 337 of Volume XXI of the Transactions of the Mining and Geological Institute of India.

These authorities give figures of the fixed deposits or relatively constant quantities of sand in the three rivers as follows:—

		Million tons.
(i) The Damodar River between the Amlabad Colliery and the extreme end of the Jharia Field		80
(ii) The Damodar River	In the Raniganj Field	543
(iii) The Barakar River	In the Raniganj Field	113
(iv) The Adjai River	In the Raniganj Field	280
(v) The Upper Damodar River in the Karanpura and Bokaro Fields		71

All of them are satisfied that these deposits are sufficient for any stowing operations that may be necessary even on an extensive scale. Our rough estimate is that not more than 10 million tons of sand will be required every year at first, working up about 16 million tons. Dr. Fox (W. No. 72) gave the following evidence before us.

"It is my definite opinion, after a careful study of the whole subject and knowing all the available relevant statistics, that the fixed deposit of sand in the Damodar, Barakar and Adjai Rivers is more than sufficient by many times to supply the quantity of sand that may, at the present rate of production,

be required even for wholesale sand-stowing in one year. I am also definitely of opinion that, whatever amount of sand may be extracted from the fixed deposit at any place in one year, would be replaced during the monsoon floods by the sand which is carried down along the beds of these rivers. If it was found in the course of years that what might be called the current account was not actually proving sufficient to replenish the fixed deposit each year, and that there was any danger of the fixed deposit being depleted to a dangerous extent, it would be quite possible, in the case of the Jharia section of the Damodar River, to increase the replacement from the current account to more than make up any such difference."

In addition to these rivers, sand is also available from the old bed of the Damodar which is about 1,000 feet broad and several miles in length, and contains deposits of sand with an average thickness of about 30 feet.

223. In considering the general question of sand supplies, it is necessary to refer to the scheme investigated by the Geological Survey of India in 1919 on behalf of the Irrigation Department of the Government of Bengal. This scheme was for the erection of a flood dam south of Parjori in the Damodar River. In conjunction with other dams in the Barakar and Kunar Rivers, this dam was considered necessary to render the lower reaches of the Damodar almost immune from floods, and to remove the potential danger of that river bursting its banks in the Burdwan Division. The project was abandoned as a result of representations made by the Indian Mining Association based on the anticipated danger of flooding the mines in the Jharia Field.

224. Since 1919, a careful geological re-survey has been made, and it is now considered that the danger to the coalfield from the percolation of water held up by the dam will not be serious. At a meeting of the Mining and Geological Institute of India held on the 22nd March 1937 near the site of the proposed dam, the whole question was again discussed in the presence of Mr. D. N. Sen Gupta of the Bengal Irrigation Department. He stated that a modified scheme might yet be considered to combine the prevention of floods with the needs of irrigation. Such a scheme would, however, only be taken up, he said, on condition that the sand trapped by the dam would be regularly excavated for use in the coalfield in order to prevent silting up of the dam and reduction of the standage area for water. The dam would be of a less height than previously contemplated; the water being allowed to run off usually in the months of October, November and December. Dr. Fox stated that the silting would be completed in less than 5 years and that nearly 36 million tons of sand would be trapped above the dam and below the Jamunia tributary. During the period of silting, replenishment of sand on the banks and in the beds of the river downstream would be almost at a standstill.

225. The site of the dam is about 4¼ miles above the B. N. Railway bridge near Mohuda, and about 2 miles below the District Board bridge on the Purulia Road. Should this dam be built, the reserves and replenishment of sand downstream would be seriously affected. These reserves, and any replenishment from the various tributaries below the dam, might be sufficient to supply the needs of the few loading points for sand already in existence for some years to come, but would not allow of any large scheme. All sand requirements would have to be excavated from the dam area which is about 10 miles from the Sijua section, and about 15 miles from the Jharia section, of the Jharia Field. With the dam full of water during the monsoons, extraction of sand would be possible only by expensive mechanical means, but after the water was let out huge quantities of dry sand would be available and the whole of the Jharia Field could obtain supplies from this one point. This would, however, involve heavy capital charges and more expensive transport, and it would, in our opinion, be more convenient and cheaper to let the river deposit sand along its course throughout the length of the coalfield.

226. REPLACEMENT OF SAND.—Dr. Fox's evidence cited above indicates that, whatever the quantity of sand extracted annually from the fixed deposits, it will be replaced during the monsoon floods by the current accounts or transitory quantities brought down by these floods. Mr. Mackie, speaking from practical experience of years (see his article on "Hydraulic Stowing of Goaves" in "Capital" of the 23rd May 1929) stated that the excavations of sand down to water level for stowing at his Bhowra and Amlabad Collieries were regularly filled up with fresh sand when the floods came down the Damodar River, and "this has continued", he adds, "year after year and sand is being loaded to-day from the site where loading began over 10 years ago. It is also interesting to note that the loading of sand has never been interrupted for more than five to seven days per year or during the days of abnormal floods only. Similar favourable sites are available at other points of the river". Mr. Mackie has informed us that what he said in 1929 has been confirmed by subsequent experience in the same spot. There is some difference of opinion as to the proportion of solid matter in suspension in river water, the Irrigation Department taking 1 in 1,200, the Port Commissioners 1 in 1,000, and Dr. Fox 1 in 100, but these differences are due to the varying speeds of flood water at Raniganj, the Hooghly River and Jharia respectively, and are not relevant to the question of replacement because it is not the material in suspension, but the material rolled along the bed, which replenishes the sand. Mr. Gee and Mr. Hobson both agree with Dr. Fox that the supply of sand by floods will be more than sufficient to make up any sand removed for stowing. It may be added that the Port Commissioners of Calcutta (W. No. 70) have told us that their experience in the River Hooghly is "that sand excavated by dredging is invariably replaced within a comparatively short period."

227. OTHER STOWING MATERIAL.—For collieries which are situated at a distance from the three main rivers, broken stone, alluvium and other suitable materials are available in large quantities. Dr. S. K. Roy, Professor of Geology at the Indian School of Mines, Dhanbad, has collected particulars of such materials available near collieries covering about 11 square miles of the Jharia Field. His total amount is 29 million cubic yards or about 39 million tons.

228. TRANSPORT AND DISTRIBUTION OF SAND.—The problem of the transport and distribution of sand to stowing collieries presents many difficulties, but these are not, in our opinion, insurmountable. For collieries situated along the banks of the rivers, independent arrangements might be made using small aerial ropeways or ordinary rope haulages as has already been done in some cases, but for collieries at a distance from rivers or other sources of sand supply, transport will have to be arranged for by the Statutory Authority or by public supply companies. The only two means of transport capable of dealing with large quantities of sand are railways and aerial ropeways.

229. RAILWAYS.—As it was not possible for us to supply sufficient relevant data when our Railways Questionnaire was issued, the E. I. and B. N. Railways were not able to give much useful assistance regarding the transportation of the then estimated tonnage of sand, namely, $1\frac{3}{4}$ million tons per month. The Agent of the E. I. Railway (W. No. 66) says that the number of wagons required to be loaded daily would exceed the average daily peak coal loading on his railway, and he thinks therefore that it is impossible to arrange for the transport by railway of such quantities of sand. The B. N. Railway have gone further into figures to show the practical difficulties. It is said that many miles of new track would have to be laid, that most of the colliery sidings would need alterations and extensions, and that much rolling-stock, etc., would have to be purchased. The estimated cost of new track is up to $41\frac{1}{4}$ lakhs in Jharia and $5\frac{1}{4}$ lakhs in Raniganj. To this has to be added the cost of rolling-stock. The probable cost of transport by rail was apparently not given very serious consideration as the following rates were quoted:—

	Per ton of sand for a minimum distance of 10 miles.
	As. P.
E. I. Railway	13 7
B. N. Railway	11 3

In both cases loading and unloading would be done by the sender and consignee. The B. N. Railway also quoted a minimum charge of Rs. 20 per four-wheeler wagon, this charge representing Re. 1 per ton of sand carried. This would be reduced by half if the

railways were to allow for sand the special rate of Rs. 10 per four-wheeler wagon which is now allowed on all coking coal moved from the collieries to bye-product coke plants.

230. It is clear, however, that, before the railways could estimate the expenditure that would be involved in the construction of new tracks, purchase of rolling-stock, etc., or the rate per ton-mile at which they could carry the sand, a survey would have to be made of the points at which sand would be stacked and delivered, and the daily quantities would also have to be estimated.

231. AERIAL ROPEWAYS.—Two supplies of aerial ropeways have provided much useful information regarding this system of transport, but again, in a problem of such magnitude, they have some hesitation in supplying figures without a detailed survey of the proposition on the spot. British Ropeways (W. No. 68) says: "Although it is easier to link up a few collieries only in the first instance, we think that a complete and comprehensive plan should be drawn up embodying the ultimate scheme, and that the links to be built in the first place should be designed with a view to suitable conversion at a later date to fit in the complete whole. If this is not done, we are sure that it will ultimately be found that the earlier links are unsuitable for incorporation in the final scheme and so much money will have been unwisely spent". With this we agree fully. Messrs. Ropeways, Ltd., says: "It should be made quite clear that anything we may say must definitely be treated as giving information on the broadest lines and all figures given are only approximate as indeed it would be impossible to work out detailed schemes in the short time available. We should also like to add that any comprehensive scheme for the transportation of sand by ropeway would entail an intensive study of the areas concerned and would, to be efficiently done, require the services of one of our expert ropeway engineers from England".

232. TWO SYSTEMS OF AERIAL ROPEWAYS.—Aerial ropeways are built on two systems:—

(i) The "Monocable" in which one endless moving rope is employed for the dual purpose of supporting and transporting the loads, and

(ii) The "Bicable", in which the loads are supported on one or more steel wire ropes along which they are hauled by a separate endless traction rope of small diameter.

Both systems have their advantages under certain conditions, and only a close investigation of each project could determine which would be the better to adopt. The monocable system is the simpler in design and is generally cheaper than a bicable ropeway of the same capacity. A monocable ropeway is limited to a maximum capacity of 150 tons per hour and a bicable to 350 tons per hour. Two monocables of 150 tons would be slightly more expensive than one bicable of 300 tons, but it might be advantageous to use double the number of monocables to meet the total capacity required

because, by so doing, a large number of loading points could be tapped and a wider distribution made without the need for a large number of subsidiary ropeways. Further, the stoppage of one monocable for any reason would cause much less dislocation and interference with the distribution of sand.

233. ADVANTAGES OF ROPEWAYS.—The chief advantages of aerial ropeway transport are:—

(i) The shortest route is taken between terminals.

(ii) Steep gradients can be safely operated.

(iii) Supporting trestles are required only at intervals and the minimum ground support is needed, a point which meets the conditions in the devastated coalfields.

(iv) The loads can be automatically discharged at any point *en route*, and at a height which allows of stacking considerable quantities of sand as required.

(v) Being constructed above ground level, no bridges nor earthworks are required, and rivers, roads, railways, and goaved areas can be easily negotiated.

It may be added that the Bengal and Bihar Aerial Ropeways Acts of 1923 and 1924 respectively were passed to authorise, facilitate and regulate the construction and working of aerial ropeways so that all difficulties regarding the acquisition of land, etc., have been removed.

234. ESTIMATED EXPENDITURE ON ROPEWAYS PLANT.—The British Ropeways Engineering Co., Ltd., estimate that the cost of material for ropeways to deal with $1\frac{3}{4}$ million tons of sand per month (as stated in the Ropeways Questionnaire) in the two coalfields for an average distance of 5 miles would be £580,000 *plus* freight, duty, foundations and erection, all of which they consider would amount to £150,000, making a total of £730,000 equal to Rs. 97,17,000. They add that "the cost of material which we have given can at the present moment only be regarded as approximate".

235. Messrs. Ropeways, Ltd., have estimated for monocable ropeways of 150 tons per hour at Rs. 1,20,000 per mile so that each ropeway 5 miles long would cost Rs. 6,00,000. Working for 18 hours per day and 276 days per year, 28 such ropeways would be required to deal with $1\frac{3}{4}$ million tons per month in both the coalfields. The total cost would thus be Rs. 1,68,00,000.

236. A comparison of the two estimates is very difficult as British Ropeways have based their estimate on 17 hours work daily, but have not stated the number of working days per month. All calculations as above have been made for a distribution of $1\frac{3}{4}$ million tons monthly or 21 million tons yearly. For 10 million tons a year, which we assume will be required at first, 6 million tons in Jharia and 4 million tons in Raniganj, the proportionate expenditure may be taken as:

British Ropeways—about Rs. 46,27,000.

Ropeways, Ltd.—about Rs. 80,00,000.

This variation in the estimates indicates the great difficulty in arriving even at an approximate figure without a full and detailed survey of the whole problem.

237. In addition to the main ropeways, subsidiary ropeways would also be necessary to distribute to the various collieries not in the direct route of the main ropeways. In the case of small collieries requiring only limited quantities of sand for protective or other purposes and situated at a distance from the main routes, transport by railway wagons could be arranged from supply points on the ropeways, thus avoiding the cost of small subsidiary ropeways which would not be in regular use.

238. WORKING COSTS FOR EXCAVATING AND CONVEYING SAND PER TON-MILE.—British Ropeways estimate the approximate cost of sand excavation would be two annas per ton by a special hydraulic method suitable for all seasons. No details of the method have been given and we are unable to say whether it would be suitable for the monsoon floods in the Damodar River. They give a cost of 6 pies per ton-mile including labour, driving power, depreciation and maintenance, repairs and renewals, but not including interest.

239. Ropeways, Ltd., give a cost of one anna per ton-mile including the cost of excavating the sand by drag-lines and all interest on capital, renewals and repairs, power and labour. The cost of excavating by drag-lines is estimated at ·75 anna per ton so that for a 6-mile ropeway the cost can be divided into ·75 anna per ton for excavation, and 5·25 annas per ton for transport; these figures are equal to ·875 anna per ton-mile.

240. As calculated in paragraph 253 below, the following estimates of the cost of excavating, loading and transporting sand have been arrived at:—

(*a*) Excavating and delivering sand to ropeway bunkers 1 anna to 1½ annas per ton.

(*b*) Transporting by ropeway ·75 anna to 1 anna per ton-mile.

(*c*) Cost of sand delivered at a point 6 miles away 5·5 annas to 7·5 annas per ton.

241. EXCAVATING SAND AND DELIVERING IT AT LOADING POINTS.—The cheapest method of excavating sand would be by manual labour. Only sand above water level could be loaded by hand, but in the dry season, in many stretches of the Damodar River, this would represent about 1 million tons per mile and in other stretches 1 million tons per 1½ miles. It might be necessary to employ mechanical means of extraction in conjunction with manual labour and the suitability of drag-lines, dredgers and grit pumps would need investigation. The use of such mechanical means would, however, add to the cost of excavation.

242. During the monsoons, the extraction of sand would be interfered with and the capacity of mechanical excavators, haulages,

etc., would have therefore to be of a capacity higher than is necessary to maintain the daily working of the ropeway or other means of transport. Large stocks of sand would have to be collected at the loading points during the dry season for distribution during the monsoon. These stocks could be loaded into the bunkers as required either by drag scrapers, or by the female labour unable to load from the river bed during the floods. After the rains break and as soon as high floods have thrown up fresh sandbanks, hand filling could be continued without many interruptions. It is probable that the requirements of sand would be less during the rains, the quantity dealt with depending on whether the pumping plant could deal with the extra " make " of water in addition to the water used for stowing at the collieries.

243. In fixing the loading points on the rivers, consideration will have to be given to the quantities of sand available, the usual course of the stream in the dry season, and the points of distribution. The supply of electric power will present no difficulty as there are public supply companies in both fields and a number of power-houses at collieries on the rivers.

244. In Jharia, a suitable length of the Damodar extends from a point downstream from the Katri Jhore for a distance of over 10 miles to beyond the B. N. Railway bridge at Bhojudih. In Raniganj, the Damodar is much broader than in Jharia and contains large quantities of sand convenient to many of the collieries that will be required to stow. In Jharia, the very thick and valuable seams that cannot be worked successfully without stowing lie conveniently close to the Damodar River.

245. At the points where a large proportion of the sand required can be obtained by hand filling, systems of endless and main rope haulages will be necessary to deliver the sand into the bunkers and into stock above flood level. Details of such plant will not be attempted here, but an approximate estimate for haulages, tubs, ropes, tramlines, gantries, etc., may be taken at not less than $1\frac{1}{2}$ lakhs per point to distribute 300 tons of sand per hour.

246. Each loading point on the River Damodar will cover a stretch of at least one mile whether mechanical or manual extraction is adopted, and haulages are required in either case to transport the sand to the loading bunkers or stocking places. To deal with 300 tons per hour at each loading point, gangs of about 600 women would be required per 9 hours shift for loading, and other labour would be needed for handling tubs and driving the haulages. One woman can load 5 tons of sand at least in a 9 hours shift. By working three shifts instead of two, and if more than 276 days in the year could be averaged allowing for Sundays, holidays, festivals and storms, the number of units might be reduced. However, by installing plant to fulfil requirements during 18 hours daily and 276 days per year, it might later be found that these units could deal with a much increased tonnage, and thus extension for some time to come would be avoided.

247. CONCLUSION.—From the information before us and from our experience, it would appear that transport by aerial ropeway is the most generally applicable method for collieries lying at a distance from the rivers. The manner of excavating the sand and delivering it to the loading points would be the same whether transport were by rail or ropeway. In many instances, the distance by rail from the loading points to collieries would be long and indirect, and the construction of branch lines to reach the rivers over rough and steep approaches would be difficult. A dual system of railways and ropeways might be possible, railways being used only where there is direct access to convenient loading points. It would be an advantage if the railways could provide, in their new rolling-stock, hopper wagons as at present used for Messrs. Tata's traffic. These would automatically unload into under-rail bunkers at the collieries and so save the cost of unloading by hand. It is not proposed that sand should be delivered at every pit-head as demanded, and collieries will have to make their own arrangements to transport the sand from the point of delivery to their stowing hoppers.

248. The most satisfactory arrangement for the supply and distribution of sand would be by a public supply company which would raise the capital, erect the plant and machinery, and contract to deliver sand as required at the various points in the coal-fields. By raising a loan of the amount required, Government should hold at least 51 per cent. of the shares in this public supply company so as to have a controlling interest and be able to decide the rate at which sand should be supplied and the profits that would be declared annually. A minimum profit of 5 per cent. free of income-tax should be guaranteed, and a fund for the redemption of the loan and the payment of interest should be created from the excess profits and a contribution from the cess funds if this should be necessary.

249. EFFECT OF COMPULSORY STOWING.—If compulsory stowing enables coal to be recovered that would otherwise be lost by avoidable waste in working, by collapses, fires, inundations and explosions, and by being locked up under railway lines, roads, buildings, village sites, rivers, etc., it is evident that the life and productivity of the collieries concerned will be increased. Leaving aside those witnesses whose evidence before us was based on experience in comparatively thin seams, the various estimates of increased life and productivity by stowing ranged from 20 to 200 per cent. Increased life means prolonging the period during which provision must be made, by a sinking fund or otherwise, for the repayment of capital. As regards annual output, this might decrease at first in some collieries, but we feel sure that shortage of labour will before long compel the more or less general installation of coal-cutting machines, and that total annual output will not therefore be appreciably affected particularly if prices go up. Applying our own knowledge and experience of conditions in the Jharia and Raniganj Fields, we would say that life and productivity will on the average

be almost doubled in both Fields. This estimate contemplates that compulsory stowing will be universal in thick seams; this should of course be the eventual aim, but it will not be practicable at first. As it will usually be impossible to say whether stowing is being required for safety or conservation, we think that all compulsory stowing must be under the Statutory Authority which should be empowered by law to require stowing for any purpose with assistance from the funds at its disposal. The Statutory Authority would ordinarily take action at the instance of the Mines Department or on the application of the mine-owner concerned. Though we recognise that the longer stowing is delayed, the higher will be the cost per ton of coal recovered, and the greater will be the loss or waste of coal meanwhile, it will not be possible to assist all at once stowing in every mine or seam where it is necessary. The organization will have to be built up and the operations extended as experience is gained. At first the determining criterion in all cases will be urgency, the urgency of the danger or the urgency for conservation against immediate loss of coal.

250. EXTENT OF COMPULSORY STOWING.—We think therefore that compulsory stowing with assistance will have to begin first in areas, conditions and seams—

(i) Where there is urgent and immediate danger to the life and safety of persons employed, as, for example, in the gassy Dishergarh seam.

(ii) Where there are fires in closed-down collieries, such as at Khas Jharia and Kusunda, which are dangerous to human life and threaten neighbouring collieries and other valuable property.

(iii) Where pillar extraction, though necessary at the moment to maintain output, cannot be undertaken because it is likely to cause crushing or premature collapse, or likely otherwise to endanger a mine, and so to involve serious avoidable waste of coal either in the same seam or in adjacent seams. Under this head would come the coal which, under Temporary Regulation 10, cannot be worked now because it is under a fire area.

(iv) Where coal of commercial or industrial value will be immediately lost or rendered inaccessible in the same or adjacent seams, or under railway lines, village sites, buildings, roads, rivers, streams, tanks, etc.

(v) Where, though pillar extraction is not immediately necessary, areas standing under weak pillars require to be stabilised in order to facilitate subsequent recovery with or without stowing.

(vi) Where the formation or strengthening of protective barriers between mines or sections of mines is necessary.

251. In addition, all collieries which are already stowing voluntarily should be encouraged to continue and be assisted, with effect from the date on which the cess is imposed, to the extent of the actual cost of extracting, loading and conveying sand to the pit-mouth. As regards collieries wishing to start stowing voluntarily after the cess is imposed, they should be required to submit their plans and estimates to the Statutory Authority, and the latter should decide in each case the most equitable terms, within the above limits of assistance, on which the stowing should be assisted.

252. Compulsory stowing with assistance would ordinarily be done simultaneously with the extraction of pillars, but it may sometimes be more economic in the long run to assist stowing during first working. Further, as sand becomes suppliable generally and the Statutory Authority is in a financial position to extend its operations, the pillar and stall method may conceivably be superseded in many seams by a modified method allowing of total extraction. This development should be encouraged where it does not conflict with safety, but it would be for the Statutory Authority to decide how the funds at its disposal can be spent to the best advantage in the interests of safety and conservation. It seems clear that, at first at any rate, compulsory stowing must be mainly protective.

253. Cost of sand-stowing.—The evidence given to us is very inconclusive as to the probable cost (per ton of sand used or per ton of coal recovered) of sand-stowing on any considerable scale because the stowing plants hitherto installed have been small in capacity and limited in range. From the evidence before us and our own experience, we think that a reasonable estimate of the average cost of extracting and loading by manual labour, and of haulage to the loading-bunker of a distributing ropeway, would be 1 anna to $1\frac{1}{2}$ annas per ton. We estimate similarly that the average cost of transporting sand by aerial ropeway would be between ·75 and 1 anna per ton-mile. These figures cover labour, power, depreciation and maintenance, but do not include interest on capital. Assuming that the average distance for which sand will have to be transported (including branches) is 6 miles in both fields, the cost would be $5\frac{1}{2}$ annas to $7\frac{1}{2}$ annas per ton of sand delivered at the colliery. These figures contemplate the excavation and loading of sand by manual labour during the dry season when sufficient sand will be available above water level. As mechanical appliances for this purpose, such as pumps or drag-lines, would cost at least twice as much, we suggest that, during the dry season, sufficient reserves of sand should be accumulated at convenient points on the river bank to cover requirements during the rains. The cost of re-loading during that period would slightly enhance the total cost, but this would still be less than for mechanical contrivances. It should be added that the above figures do not include any provision for royalty or other charge on the sand itself. This point will be discussed separately.

254. To facilitate inspections at loading points and the transport of machinery, stores and labour, the construction of connecting roads will be necessary and will have to be arranged for by the Statutory Authority. As the labour force required will be large, it will also be necessary to provide bus transport from the collieries and villages. It should be remembered in this connection that female labour will be available in large quantities as soon as women are debarred from underground work after the 1st July 1937. The Statutory Authority should use this labour as much as possible to the exclusion of men as this would solve what will otherwise be an acute problem and tend to keep the colliery labour force contented as a whole.

255. As regards the average cost of underground stowing (including labour, stores, pumping and plant depreciation, but excluding interest charges) we similarly estimate this at from 4 annas to 7 annas per ton of sand. This is necessarily only a very approximate estimate as the cost of this item must vary with the vertical head and horizontal lead, the thickness of the seam and the depth from which pumping has to be done, the latter being the greatest factor of variation. In some collieries, sufficient water for hydraulic stowing will not be available and will have to be arranged for by the Statutory Authority. In such cases, pneumatic or mechanical stowing might be found more economical.

256. Assuming that on the average 50 per cent. has been extracted in first working, 2·7 tons of sand will be required to replace every ton of coal recovered. On the basis of our preceding approximate estimates therefore, the average cost per ton of coal recovered from pillars will vary from Rs. 1-9 to Rs. 2-7. It should be remembered that these figures are for complete stowing and for transportation of sand for an average distance of 6 miles. We are satisfied that partial stowing, such as has been done at the Amlabad Colliery, will sometimes give quite sufficient support. Besides, the cost per ton will be considerably less when it can be distributed over the whole output of a colliery in which a considerable portion of the output is being obtained from galleries without stowing. The average cost of total replacement per ton of coal raised from virgin areas will be from 12·8 annas to Rs. 1-3-6, again with an average distance of 6 miles.

257. We are of opinion that the above figures of the cost of stowing would be reduced to some extent by savings on timber (particularly in the thicker seams), fire stoppings (the necessity for which would practically disappear) and compensation for land, buildings and accidents. As regards pumping, the cost would undoubtedly be increased as a result of hydraulic stowing because the water used has to be pumped out, but on the other hand the "make" of water through surface breaks or very heavily-watered overlying strata would be eliminated. Dealing with such water is a permanent and increasing item of cost with present methods, the result sometimes being to hamper or prevent dip development because pumping charges are above the economic limit. There

would therefore certainly be a considerable ultimate saving on pumping. Finally, output would be more concentrated and regular though it would also be less flexible. Though our witnesses do not agree, one of our members (Mr. Mackie) who has long practical experience is of the opinion that the cost of coal-getting will also be reduced.

258. ROYALTY ON, OR OTHER PAYMENT FOR, SAND.—The principal landlords who own the sand in the Damodar, Barakar and Adjai Rivers are:—

(i) the Ramgarh Ward's Estate in the upper reaches of the Damodar,

(ii) the Jharia Raj Estate in the Damodar in the Jharia Field,

(iii) the Burdwan and Panchkote Estates in the Damodar in the Raniganj Field,

(iv) the Kasimbazar and Panchkote Estates in the Barakar, and

(v) the Burdwan and Hetampur Estates in the Adjai.

According to its representative (W. No. 59) the Bengal Coal Co. (managed by Messrs. Andrew Yule & Co.) owns sand rights over 8 miles of the Damodar mainly in the Raniganj Field, while the whole of the Jharia Raj rights over sand have been leased for 999 years from June 1935 to the Bhulanbararee Coal Co. (managed by Messrs. Bird & Co.); the Equitable Coal Co. (managed by Messrs. Macneill & Co.) has been given the right to take sand free of charge for stowing purposes from the Panchkote Estate portion of the Damodar River. It is apparently settled law that the beds of non-navigable rivers belong to the riparian proprietors, and these proprietors regard sand as a mineral excluded from ordinary leases of surface land. Sand has, however, been a practically valueless commodity hitherto and is besides renewed annually by Nature without any effort or enterprise on its owner's part. Compulsory stowing will introduce a big demand for sand, but this measure of conservation will be taken in the national interest and the owners of sand rights should not be allowed to profiteer or to sell at such an inflated price as will interfere financially with the stowing operations. That this might occur and also that there might be speculative purchases of sand rights, such as the Bhulanbararee Coal Co. seems to have made, was recognised by the Government of India in the following terms in letter No. M76-140 of the 23rd May 1921 dealing with the 1920 Committee's proposals:—

> "In view, however, of the opinion which the Government of India have formed of the absolute necessity of sand-stowing in the case of a large number of mines, they are provisionally of opinion that steps should be taken at an early date to render sand available on payment of a reasonable royalty. The demand for sand, which has already arisen in consequence

of the very limited operations which have been undertaken, has had the effect of inducing landowners to put up the price of what has hitherto been looked on as an almost valuless commodity; and there seems little doubt but that, as this demand increases, the price of sand will rise to a figure which will interfere very seriously with its use on an extended scale. While ready to allow generous compensation for interference with private rights, even if they have been of little or no practical value heretofore, the Government of India are strongly of the opinion that the owners of such rights cannot be allowed to profiteer to an extent which would seriously interfere with the production in the national interest of so great an economic asset as coal; and they therefore propose to take power to acquire from time to time, and at such future dates as may be necessary, all sand that enquiry may show to be necessary for the due conservation of coal in the Raniganj and Jharia Fields and in their western extensions, on payment of a royalty calculated on a basis to be fixed with reference to the present conditions."

In dealing with the same subject in letter No. 290-VIIM-34/Com. R., dated the 19th August 1936, to the Government of India, the Government of Bihar said:—

"The task of collecting and distributing the sand should, in the opinion of the Local Government, be undertaken by the State. Legislation should be introduced permitting Government to take from the river beds whatever sand is required for sand-stowing without acquisition of the river beds or payment to the proprietors. This will be the *zemindars'* contribution to the cost."

259. The evidence (see W. No. 62) shows that the Bhulanbararee Coal Co. paid only Rs. 5,000 *salami*, and an annual rent of Rs. 1,000, for a 999 years' lease over the sand rights in the whole bed of the Damodar River in the Jharia Raj Estate. The sand is to be used for the purposes of stowing coal mines only. We think that the State would be justified in taking over this lease with the usual 15 per cent. premium for compulsory acquisition. As regards the general question, the precise methods by which Government should counteract any risk of profiteering or inflating prices is a matter for legal advice. One suggestion to us has been that Government should legislate so as to provide that no transaction after a certain date will be taken into account in assessing the compensation to be paid for sand. We are inclined to think that the State should legislate to give the Statutory Authority the right to sand supplies for stowing purposes at a fixed annual rent per acre of surface. In the Central Provinces, the Local Government charges only $5\frac{1}{2}$ annas per acre per year for sand from the Wardha River to be used for sand-stowing in the Ballarpur Colliery. The rate paid should include way-leave from the point of excavation to

the loading-bunker of the distributing ropeway. Surface land required for stacking would be arranged for by the Statutory Authority or acquired temporarily by that Authority under the Land Acquisition Act.

260. FINANCING OF COMPULSORY STOWING.—We have now to consider how compulsory stowing for purposes of safety and conservation should be financed. One view put forward by a few of our witnesses is that the additional expenditure involved should be met by the colliery companies concerned and that, if such companies are unable to continue working under this added burden, they should close down until market conditions improve to the extent of enabling them to pay for sound mining methods. We are definitely of opinion that this is not practical politics more especially as it would prejudice safety because the mines that were shut down would not be inspected and no one would know what was going on inside them. Another view is that, as the justification for compulsory stowing is the national interest, the State should bear the whole cost and distribute it over the whole country. This again is hardly practical politics and is without precedent so far as we are aware. Government would have to obtain the necessary funds from the general body of tax-payers, and there is no justification for penalising everybody in order to benefit the coal trade and industry, and facilitate its escape from difficulties for which it is at least partly responsible. The opinion of most of our witnesses, with which we agree, is that the necessary money should be obtained from a general cess on all coal (including soft coke) and hard coke (unless the coal from which it has been made has paid the cess already) despatched by rail in and into British India. This cess would be collected by the railways as a surcharge on railway freight from the party paying that freight, and would be credited to the Statutory Authority under the same procedure as is now followed under the Indian Soft Coke Cess Act VIII of 1929.

261. APPLICATION OF PROPOSED CESS.—Points that immediately arise are whether this cess should be at the same rate on all qualities of coal and whether it should be applied universally to all coalfields. As regards the first point, the only alternative worth considering is two rates (i) on selected and grade I coal, and (ii) on grade II and grade III coal. The East Indian Railway (W. No. 66) says that such differential rates could only be collected provided the railway staff was not held responsible for determining the quality of coal in order to fix the correct rate of cess, mine-owners being required by law to make a correct declaration of quality with a system of certification of despatches worked by the Statutory Authority administering the cess. The Bengal-Nagpur Railway (W. No. 67) says that it cannot undertake to collect a cess at two different rates on two different grades of coal unless the Statutory Authority issues a certificate for each wagon of coal. It is evident that some check by inspection or otherwise would be

necessary in order to prevent fraud and evasion by collieries producing and selling different grades of coal. Collection with freights by the railways is obviously the most economical method of collection, and the necessary checks would have to be paid for out of the cess funds and would reduce correspondingly the amount available for stowing. Besides, there is really no justification for charging inferior coal a lower rate of cess because Tables II, III and IV attached to our Report show clearly that the amount of good quality coal mined and sold varies inversely with the prices obtained, more being extracted as prices decline, and less as prices increase. The figures for three or four years will establish this conclusively.

Year.	Jharia coal.		Raniganj coal.	
	Percentage output of superior coal.	Pitmouth value.	Percentage output of superior coal.	Pitmouth value.
		Rs. A. P.		Rs. A. P.
1920	71·7	4 10 0	75·0	6 2 0
1922	59·3	6 14 0	74·4	9 5 0
1930	76·9	3 10 0	91·5	4 0 0
1934	77·2	2 8 0	94·1	2 10 0

It follows that, if a general cess at the same rate increases proportionately the prices paid for all coal, the result will be a greater comparative demand for inferior coal. Again, most of the output of inferior coal below grade II is now converted into soft coke on which there is already a cess of 2 annas a ton. As we intend that soft coke should pay a cess of 8 annas to the Statutory Authority only, that Authority handing over to the present Soft Coke Cess Committee a portion of the proceeds equivalent to collections at 2 annas a ton, the inferior coal used in manufacturing soft coke will really only be paying an extra 4 annas a ton towards the cost of compulsory stowing because it takes $1\frac{1}{2}$ tons of coal to produce 1 ton of soft coke.

262. As regards the second point, we are aiming at leaving all coal producers in more or less the same relative position as they are now. It has been suggested to us that there is no justification for imposing a cess on collieries which are unlikely to benefit from the cess because they can be worked safely and economically without stowing. This is a plausible argument, but it overlooks the practical difficulties of differentiation in coalfields such as Raniganj and Jharia, where the collieries often contain several seams some of which, owing to their comparative thinness and

relative position in the strata, do not need stowing while the other comparatively thick seams do, and also because, though such comparatively thin seams may not need stowing in their ordinary workings, they will need it in order to recover coal under railways, rivers, buildings, tanks, etc. As regards other fields, the Central Provinces Government (W. No. 47) admits the necessity for stowing in the Chanda Field, where the coal in pillars can never be recovered at all without stowing, but says that, as stowing will not be necessary in the Pench Valley Field, the cess should not be made applicable to the latter field. Apart from the practical difficulties inherent in any such differentiation between fields in the same Province, the idea that a cess or any other tax can be imposed in proportion to benefit received is unsound economically. All collieries, for instance, have to pay road cess at 1 anna in the rupee on their net working profits though some collieries must necessarily receive much more benefit from the District Board roads than others. Besides, though some collieries with seams as described above may never need stowing for purposes of conservation, they will benefit by compulsory stowing from the point of view of safety because there will be no danger of fire breaking into them from neighbouring collieries nor will they be compelled to leave big barriers to protect themselves. Finally, it will not be practicable to stow compulsorily at once all collieries where stowing is necessary. The Statutory Authority must proceed at first with primary regard to the comparative urgency of stowing for safety or conservation or both, and the imposition of the cess only on those actually benefited would limit its payment to a comparatively few companies and would render impossible any hope of achieving the ultimate aim of gradually extending stowing to all collieries with conditions that require it. Another argument against anything but a general cess is that collieries compelled to stow either at first or in future should not be placed at a competitive disadvantage, both as regards price and output, with those not so compelled now nor likely to be compelled later. They would be unable to sell their coal if they alone had to pay the cess, and there is clearly not much point in evolving big schemes in the national interest to make coal safer to work or available in larger quantities if at the end of all this the coal itself cannot be sold. Further State control over working methods is justified fundamentally in the national interest. Control over methods to prevent avoidable waste and enforce efficient and safe working must be universal, and compulsory stowing is the most generally effective of such methods. It follows that the additional cost of compulsory stowing should be borne by the whole of the coal trade and industry. It may be added in conclusion that, if the cess is not general, it cannot be passed on to the consumer by the producer because the consumer will be able to buy other coal on which the cess is not being paid. It is essential under existing conditions that the trade and industry should not be further burdened, but steps should also be taken to protect the interests of consumers by some organisation to control output

and prices on the lines suggested by us in paragraph 330 of Chapter XIII. Finally, a general cess would *pro tanto* increase the resources available to the central rationalising body for helping the coal trade and industry in the national interest.

263. As this question of the applicability of the cess is most important and will almost certainly prove controversial, we wish to cite, in support of our views, the following opinions expressed in the course of the correspondence which took place in 1936 in reply to Government of India letter No. M. 955 of the 17th June 1936 and which led to the appointment of our Committee:—

I. In a letter to the Government of Bengal, dated the 31st July 1936, the Indian Colliery Owners' Association said that it was opposed to the enforcement of sand-stowing, but added that, "if there is to be a cess for compensating those collieries who have to adopt sand-stowing, it should cover all coal mined in, and imported into India. Although the Committee do not agree in the imposition of cess, I am desired to say that if cess is inevitable, it must extend to every Indian coalfield and should be imposed on despatches of all coal and coke and collected by the railway companies along with the railway freight".

II. In a letter of the 6th August 1936 to the Government of Bengal, the National Association of Colliery Managers (Indian Branch) said that a compensation fund would be necessary, and added that "this would be provided by a cess on all coal and hard coke despatched and collected throughout India by the Railways on the coal despatched as detailed in the Report of the Coalfields Committee (1920)".

III. The Government of Bihar, in letter No. 290-VIIM-34/Com. R. of the 19th August 1936 said: "The view of the Local Government on this question is that it is out of the question to introduce a system of compulsory sand-stowing without relieving the collieries of any part of the burden of the added cost of extraction, which may be taken to be in the neighbourhood of one rupee a ton. It is also useless to impose a cess only on the coalfields to which the compulsory scheme will apply, otherwise the competition of other coalfields would put them out of business. The question must be looked at from the point of view of the conservation of an all-India national asset, and consumers throughout the country should pay the bulk of the cost of the scheme of conservation".

264. ACCOMPANYING IMPORT DUTY AND EXPORT DRAWBACK.—Continuing the general idea of leaving every one concerned in

more or less the same relative position, it will be necessary to accompany the cess by an equivalent countervailing import duty on foreign coal and coke, and an equal drawback on coal and coke exported to foreign countries. South Africa would certainly object, and might indulge in tariff or other reprisals, if anything in the nature of a protective import duty were imposed, but she could not reasonably object to a countervailing duty of exactly the same amount as the cess imposed on all Indian coal. If the proceeds of the countervailing duty are handed over to the Statutory Authority as an addition to the cess funds, then the Statutory Authority should pay the drawbacks also. If the Government of India retain the proceeds of the countervailing duty they should also pay the drawbacks, and this would probably be the simplest arrangement in practice as both transactions would have to be conducted by the Customs Department.

265. AMOUNT OF PROPOSED CESS.—As regards the amount of the proposed cess, we are of the opinion that 8 annas a ton on coal (including soft coke) and 12 annas a ton on hard coke (assuming that $1\frac{1}{2}$ tons of coal are necessary to manufacture 1 ton of hard coke) will be the lowest rates likely to provide adequate funds for the work contemplated at first. An undertaking should be given by the Government of India that these rates will remain in force for the first three years during which the work will be exploratory and experimental. It should be possible, at the end of that period, to ascertain definitely, on the basis of experience supported by facts and figures, whether the above rates are too high or too low for the objects in view both immediately and ultimately. In order to guard against any possibility of the available funds being either too large or too small, any legislation on the subject should provide for maximum rates of Re. 1 and Re. 1-8 a ton respectively, and should give the Government of India power to alter the initial 8 annas and 12 annas rates either way after three years and with due notice to the trade and industry. The cess itself should be imposed as soon as possible in order that funds may accumulate while the Statutory Authority is being constituted and working out suitable schemes.

266. The cess should be collected by the railways and be paid to them by those who pay the freight. As the prepayment of freight is not usual in the coal trade, the impact of the cess will fall on the consumers, but its incidence will be determined by market conditions of demand and supply. Even if the whole cess falls ultimately on the consumer, he cannot reasonably complain as he has been obtaining coal for years at absurdly low prices, and will in any event have to pay more for inferior coal all the sooner if the good quality seams continue to be worked out at the present rate. Further, though pit-head value may be raised by the amount of the cess, the proportional increase in the price paid by most consumers will be much less. According to the figures at pages 3 to 5 of "Indian Coal Statistics, 1935", the

average pitmouth value of coal was Rs. 2-13 per ton in 1935, while the declared export value was Rs. 8-9. Freights per ton from the coalfields in the same year were:—

Railway freight for full wagon loads at owner's risk.	From Raniganj.	From Jharia.
	Rs. A.	Rs. A.
To Calcutta	3 12	5 2
To Cawnpore	7 15	7 7
To Delhi	9 14	9 10
To Lahore	12 0	11 12
To Bombay	12 6	12 6
To Karachi	15 7	15 0

	Sea freight in December 1935 from Calcutta.
	Rs. A.
To Bombay	6 8
To Madras	4 2
To Rangoon	3 12
To Karachi	6 9
To Colombo	5 2
To Singapore	4 14

These figures make it clear that freights are always more than, and are sometimes four to five times as much as, the pitmouth value per ton.

267. We have already suggested in Chapter VII that the railways should collect the cess without charging any commission, this being regarded as their direct contribution towards the cess funds. In addition they will have to pay the cess on coal and coke despatched for their use both by private companies and from their own collieries. The Chief Mining Engineer to the Railway Board (W. No. 37) said that he does not expect any practical difficulty in realising the cess on these despatches and crediting the proceeds to the Statutory Authority by book transfer.

268. We are of opinion also that the landlords should contribute directly to the cess because the life of their properties will be increased, royalties will be paid to them on coal which would not otherwise be worked, and the State will, by controlling methods of working in various ways, assure the proper working of their mines. We suggest that all landlords should pay 10 per cent. of the royalties actually received by them each year. Where no royalties are being paid because the royalty rights have been acquired by the mine-owner, or where only a dead rent is being paid, it should be assumed that royalty-rights are worth 4 annas a ton on coal despatched less dead rent, if any, and 10 per cent. should be paid on the net amount. In order to facilitate collection by the Statutory Authority in both cases, every mine-owner should be required to submit to the Statutory Authority by the 20th April of each year a statement showing the despatches of

coal by rail during the previous financial year, the name of the landlord or landlords, and the amounts of royalty and dead rent paid to each landlord. The Statutory Authority will issue demand notices on the basis of these statements, verified as that Authority may consider necessary, and the amounts due will be realizable as public demands if not paid by the 1st September of each year. It is most important also that, whatever may be fixed as the contribution which should be made directly to the cess funds by landlords, it should be laid down by law that this contribution will be payable by the landlords themselves irrespective of such terms in existing leases which say that any taxes, cesses, or other demands imposed by Government or any local authority in connection with the leased property will be payable by the lessee and not by the lessor.

269. Finally, there is the question whether Government should contribute to the cess funds. Where, as in the Central Provinces, the Local Government owns the minerals, it will contribute to the cess funds as a landlord. Elsewhere, and particularly in the more important Raniganj and Jharia Fields, the Government of India contribution should take the form of paying for the extra staff to be proposed later for the Mines Department, for part of the permanent staff of the Statutory Authority, and for research to the extent proposed in paragraph 343 *post*. In addition, all plant and machinery for stowing purposes, imported by, or under a certificate from, the Statutory Authority should be allowed into the country free of import duty. We contemplate of course that such material would as far as possible be purchased from manufacturers in India provided its quality is as good and it is available when required.

270. Extent of Assistance.—The next question is the extent to which assistance should be given to collieries required to stow for any reason. The word " compensation " has been used in this connection, but it should be made clear that assistance or compensation is necessary not because mine-owners are entitled to it on the ground that their right to win their coal as they please is being restricted, but because compulsory stowing would—

(i) place the stowing collieries at a competitive disadvantage and might drive them out of the market, and

(ii) affect some stowing collieries more than others according to distance from the sources of stowing material.

Our main object is to make stowing an economic proposition having regard to the extent to which coal has been extracted in first working, but without allowing the assistance to tip the scale into financial gain. If the assistance extends as far as free supply of sand at the colliery, the administration of the cess would be simpler and cheaper, stowing could be done on a larger scale, more coal in pillars could be recovered, and greater stabilisation could be achieved. It has been suggested that many mines would be unable to stow economically with this amount of assistance and would have

to shut down. We are inclined to agree that, if this were to happen to any great extent, the potential danger might be increased rather than diminished, but this could be counteracted if, as we suggest later, the Statutory Authority were empowered to take over such properties and either work them itself or transfer them to others willing to work them. We do not, however, expect that such cases will be numerous, or will occur at all among the larger companies which control about 85 per cent. of the output of good quality coal. Some companies are already stowing without any assistance, partly because they can distribute the cost over the rest of their output, and partly because they have other valuable seams which are worth saving for the future. Finally, prices have already risen owing to shortage of supply, and will, in our opinion, continue to rise owing to decrease of output due to (i) control of first working, section-working and depillaring, (ii) compulsory stowing, and (iii) the withdrawal of female labour. We think therefore that the assistance given out of the cess funds should not extend beyond the supply of free sand at the colliery for the first three years when the eight and twelve anna cess rates are in force. After that the position should be reviewed in the light of experience, accomplishment and general results, but we anticipate that, if further assistance is then considered necessary, the cess rates will have to be increased.

271. If our arguments in this connection do not prove conclusive and some additional assistance beyond free sand-supply is considered necessary, we think that such assistance should be related only to the cost of putting the stowing material in place underground (including overhead charges, depreciation on plant, repairs and replacements) excluding the cost of pumping. Of our previous estimate of 4 to 7 annas per ton of sand for the whole cost of underground stowing, about 1 to 5 annas represents the cost of pumping. As the continuous and ultimate saving on pumping will be far greater than the cost of pumping during stowing, no assistance should be given so far as pumping is concerned. This would reduce the further assistance on the average to about 3 annas per ton of sand put in or about 8 annas per ton of coal removed. We do not think that the whole cost of this part of underground stowing should be paid or refunded because the collieries that will need most assistance in this respect are those which have worked least satisfactorily and extracted the largest percentage during first working. The best plan, therefore, would be to have a flat rate based either on the sand put in or the coal taken out. Such a flat rate would cost the cess funds less and would also be an incentive to collieries to do the required stowing as cheaply as is consistent with efficiency. The data before us are not sufficient to enable us to say what the flat rate should be, and this must be left to the Statutory Authority to fix after making enquiries with that object in view. The flat rate so fixed should, in our opinion, be per ton of sand stowed and not per ton of coal recovered. Evasion will be possible on either basis, but, after considerable discussion, we have come to the conclusion that the

sand basis is the better of the two on the whole. In fixing the amount of the flat rate, the Statutory Authority should see:

(i) that collieries which have extracted a comparatively larger percentage in first working, or robbed pillars and galleries subsequently, do not receive the same proportionate assistance as those which have extracted a sound mining percentage and have not indulged in practices which have lessened stability and made the recovery of pillars more difficult and dangerous; and

(ii) that no colliery is either able to stow at a profit or is so much burdened as to make further work prohibitive.

272. In addition to such assistance as may be decided on, the Statutory Authority should also be able to make advances, when such advances are shown to its satisfaction to be really necessary, for the purchase of pipes and plant by collieries where stowing has been ordered. These advances should be a first charge on the property concerned, should be recoverable within three years from the first working of the plant, and should bear the same rate of interest as the Statutory Authority has to pay for the accommodation in the money market or from the Government of India.

CHAPTER XI.

Proposed Statutory Authority.

273. Functions of Statutory Authority.—Several references have been made to a proposed Statutory Authority, and we have now to consider what the functions of that Statutory Authority are to be and how it should be constituted by law. We have adhered to the term " Statutory Authority " in our report because it was used in our questionnaire, but any authority constituted by law is a statutory authority, and the designation of our Authority should therefore be Coal Conservation Authority. Its headquarters should be at Dhanbad and its principal functions to begin with should be:—

(i) Administration of the cess and all arrangements for excavating and transporting sand to the collieries—see Chapter X.

(ii) Control over all compulsory and assisted voluntary stowing whether for safety or conservation—see Chapter X.

(iii) Control over section-working of seams or parts of seams —see paragraph 209 of Chapter IX and paragraph 160 of Chapter VII.

(iv) Control over depillaring—see paragraphs 211 and 212 of Chapter IX.

(v) Control over rotation of working—see paragraph 213 of Chapter IX.

(vi) Control over measures to extinguish or circumscribe existing fires in closed-down collieries which are dangerous to life or property—see paragraph 250 of Chapter X.

(vii) Control over new leases within the limits stated in paragraph 139 of Chapter VII.

(viii) Control over amalgamation of small properties, adjustment of irregular boundaries, transfer of isolated coal-bearing areas which cannot be conveniently worked from the parent property, and treatment of abandoned mines —see paragraphs 331 to 337 of Chapter XIII.

(ix) Direction of research—see paragraph 343 of Chapter XIII.

274. Coal of commercial or industrial value.—Speaking generally, coal of industrial value is coal which has value in use as fuel, and coal of commercial value is coal which has value in exchange as a marketable commodity. Various more precise definitions were suggested by some of our witnesses, while others said that no comprehensive definition was possible nor would be of practical use. One witness said that coal of commercial value is coal which can be raised or sold at a profit; another said that it is coal now in demand as a trading commodity or likely to be so in the not distant future in the light of present knowledge; another

defined it as all coal which can be worked at a profit under normal trade conditions, another as any seam of coal over four feet thick which has previously been mined and sold in the open market, and yet another said that it was any coal which can be used as fuel to-day, to-morrow or at any time to come. The criterion of exchange value at a profit is not conclusive because nobody would suggest that good quality coal in an area from which there are no transport facilities has no value merely because it cannot be worked and sold at a profit until such facilities are provided. We agree, however, that a permanent definition of coal of commercial or industrial value is difficult because coal which can be profitably worked or used at one time may not be saleable or usable at another. A transient definition is also difficult because coal which is commercially valuable in one place cannot be sold in another, while even in the same locality one mine-owner can win and sell coal which another mine-owner considers worthless because he has other coal which he can work more profitably. A definition would be of great assistance to a Statutory Authority which has to decide how, when and where coal is to be won in depillaring or section-working or adjacent seams, and any such definition should evidently subordinate the commercial point of view to national interest and mining possibilities. In India to-day, coal of a quality not better than grade III is being raised and sold profitably in the Central Provinces because of its geographical advantage in the markets of the Bombay Presidency. The Statutory Authority will, however, be concerned mainly with the Raniganj and Jharia Fields where the greatest danger and the greatest avoidable waste occur. In these Fields, coal below grade II in quality has very little commercial or industrial value at the moment, but we consider that on the whole it will be better not to attempt even a transient definition of coal of commercial or industrial value, leaving it to the Statutory Authority to decide each case with reference to the particular circumstances including safety, and with reference also to the time at which the decision has to be taken.

275. Statutory Authority and the Mines Department.—The 1920 Committee suggested that there should be a Mines Department for safety and a Coal Conservation Department for conservation, both to be under a Controlling Authority consisting of a Board sitting in Calcutta. We do not approve of this arrangement and think that the Chief Inspector of Mines should continue to control the Mines Department without any other authority between him and the Government of India. As the duties and responsibilities of the Mines Department will be increased appreciably if our proposals regarding principles of first working, more detailed regulations, etc., are accepted, we consider that the Statutory Authority, with the functions suggested above, should be quite distinct from the Mines Department. At the same time, we consider it essential that the Chief Inspector of Mines should be a member of the Statutory Authority and that the Mines Department (strengthened for this and other purposes) should be the executive

agency of the Statutory Authority so far as all underground operations are concerned, *e.g.*, the Mines Department would report on all cases before the Statutory Authority with reference to underground conditions, would bring to the notice of the Statutory Authority relevant cases which are not brought before it by the mine-owner concerned, would see that the orders and directions of the Statutory Authority affecting underground work are carried out promptly and efficiently, and would inspect underground stowing arrangements and satisfy the Statutory Authority that the stowing itself is adequate and properly done.

276. Powers of Statutory Authority.—We strongly recommend that the orders of the Statutory Authority should be final as regards all its functions. The only possible appeal would be to the Government of India who would have to appoint a Committee or other similar body to hear such appeals. That appellate body, even if it were a permanent one and not appointed for each appeal as in section 11 of the Indian Mines Act, would have to be constituted with an administrative or judicial Government officer as chairman and with mining engineers as members, and the position would evidently not be a satisfactory one so far as the Statutory Authority is concerned. We do not suggest of course that the Statutory Authority should decide important issues summarily or without fully hearing the parties concerned. Further, the Statutory Authority would always have inherent power to revise its own orders if new facts or new grounds were put forward.

277. As regards the enforcement of its decisions in connection with the functions allotted to it, the Statutory Authority should have the same legal powers, with the same penalties attaching to active contravention or passive disobedience, as the Mines Department has or will have so far as orders about safety are concerned.

278. Constitution of Statutory Authority.—The first question in connection with the constitution of the Statutory Authority is whether it should be a representative or an expert body. If the Statutory Authority were representative, the following interests could claim representation, namely, Government, the Mines Department, the Geological Survey, the Railway Board, royalty-receivers, mine-owners, colliery managers, labour and consumers. Some of these interests are represented by various Associations all of whom would have to be consulted, while "consumers" is a general term covering railways, iron and steel industries, shipping firms, and other industries such as cotton, jute, etc. A fully representative body would therefore be very unwieldy, and most of the members would be concerned primarily with the particular interest they represented rather than with national and mining interests. It is because the Government of India saw little or no prospect of unanimity among those interested on the important issues involved that our Committee is an expert and not a representative one.

279. We are therefore definitely in favour of an expert Statutory Authority constituted as follows:—

(1) an independent Chairman,

(2) the Chief Inspector of Mines,

(3) one commercial expert,

(4) three mining experts,

with power to co-opt the Director of the Geological Survey or the Chief Mining Engineer to the Railway Board, or both, when the Chairman considers this necessary.

280. As regards the independent Chairman, the choice lies between a mining engineer from Great Britain with no direct or indirect connection with mining interests in India and a senior official of administrative experience, used to determining disinterestedly the balance of advantage between conflicting views in matters of public and private importance, trained to putting the public interest above other considerations, and accustomed to arranging practical compromises under expert advice. Of the 13 witnesses who were questioned specifically on this point, 10 were in favour of an official Chairman, while 3 favoured an expert Chairman. As a mining engineer from Great Britain would have no knowledge of the people or the peculiar mining conditions, we are definitely in favour of an official Chairman of the type indicated above. The rules of business of the Statutory Authority should give the Chairman a casting vote at meetings and should confer on him the authority (i) to dispose of unimportant cases and routine matters, and (ii) to exercise all the Statutory Authority's powers regarding the carrying out and enforcement of its orders as a body.

281. As regards the Chief Inspector of Mines, a few witnesses suggested that the Statutory Authority should be independent of the Mines Department, but, of the 16 witnesses who were orally examined on this point, 13 said that the Chief Inspector of Mines should be on the Statutory Authority. The principal reason for this is that safety and conservation are very nearly allied, and that it will usually be difficult in practice to determine whether compulsory stowing is necessary in the interests of safety or of conservation. There is no doubt that measures which increase safety also improve conservation, and that measures which make for conservation also make for greater safety. We think therefore that all compulsory stowing, whether for safety or conservation, should be looked after by the Statutory Authority, and that it is essential that the Chief Inspector of Mines should be a member of that Authority, especially as the Mines Department is to be responsible for the underground operations in connection with the conservation and stowing orders of the Statutory Authority. It should be provided that, if the Chief Inspector of Mines is unable to attend any meeting of the Statutory Authority, he will be able to depute a senior officer of his Department to take his place with full power to discuss any subject and record a vote.

282. As regards the commercial expert, we think that he should be selected for each meeting by the Chairman from a panel of 5 such experts with wide knowledge and experience of the coal trade. The panel should be appointed for three years by the Government of India after such consultation with the commercial interests concerned as may be considered necessary. These commercial experts should, however, be men of real standing in the coal world and, preferably, partners in their respective firms.

283. As regards the mining experts, there should be a similar panel of 10 mining engineers appointed for three years by the Government of India and selected from among mining engineers having wide knowledge and experience of the Indian coal industry. The three members to sit at each meeting of the Statutory Authority would be selected by the Chairman with reference to the questions for decision and excluding any member connected with the interests directly affected.

284. SALARY AND ALLOWANCES.—As regards the salary and allowances of the members of the Statutory Authority, the Chairman should be a whole-time officer and should be paid by the Government of India. He should be of the standing of a Commissioner or senior District Officer and should receive an allowance in addition to his grade pay sufficient to permit of his remaining in the post for at least three years. It is the first three years that will be the crucial period in the life of the Statutory Authority, and we strongly recommend that the officer appointed as its first Chairman should be carefully selected, adequately remunerated, and required to serve, barring unforeseen accidents, for the whole three years. The other members, except the Chief Inspector of Mines, would be paid a fixed fee *plus* first class travelling allowances for attending meetings, their fees and allowances being paid out of the cess funds.

285. In addition, the superior staff of the Statutory Authority should consist of a Secretary with accounts experience and some knowledge of finance, and a qualified Ropeways Engineer. The Ropeways Engineer will be essential if aerial ropeways are to be the principal means of transporting sand to the collieries. These two officers should be appointed by the Government of India on Rs. 1,000—100—1,300 on three-year contracts with six months' notice and an option of renewal on either side. Such subordinate staff as may be necessary for office, surveying or other purposes will be appointed by the Chairman and paid out of the cess funds. All travelling allowances of the superior staff at the usual rates under the Fundamental Rules should also be paid out of the cess funds.

286. STAFF OF THE MINES DEPARTMENT.—We are further of opinion that the present staff of the Mines Department will have to be increased. The responsibilities of that Department have increased appreciably in recent years, and we are suggesting in this Report a considerable further addition to those responsibilities.

It is not much use having general principles of first working, control of section-working and depillaring, and a complete set of regulations, if the responsible staff is not adequate to the work of seeing that these various measures of control are actually carried out and enforced where necessary. We have consulted the Chief Inspector of Mines in this connection and agree to the following proposals put forward by him:—

287. The present sanctioned superior staff of the Mines Department is as follows:—

1. Chief Inspector.
2. 3. 4. Three Inspectors, one in charge of each Circle and one additional.
5. One Electric Inspector.
6. 7. 8. 9. Four Junior Inspectors.
10. 11. Two Assistant Inspectors.

It is suggested that this staff should be increased to—

1. Chief Inspector.
2. Deputy Chief Inspector.
3. 4. 5. Three Inspectors.
6. One Electric Inspector.
7. 8. 9. 10. 11. 12 Six Junior Inspectors.
13. 14. 15. 16. 17. 18. Six Assistant Inspectors.

The grounds on which this increase of staff is justified are:—

(*a*) The mining legislation during the last year or two, and the probable additional legislation in the near future, will necessitate additional staff to cope with the extra work involved.

(*b*) The regulations to deal with the coal-dust problem will impose additional duties on the Inspectorate. For example, Inspectors may have to collect, and perhaps analyse, samples of coal and stone-dust so as to provide a check on the analyses done by mine managers.

(*c*) Owing to the great increase of fires in the coal mines of both Circles, the work of the Inspectors has grown tremendously. Instead of two Circles, the mines of British India should be grouped into three Circles with an Inspector in charge of each. It may be added in this connection that we shall suggest in Chapter XIV that the Mines Department should inspect the Central Provinces mines with reference to the Government leases as well as regards safety.

(*d*) The Mines Department will have to undertake appreciable additional work in connection with the functions of the Statutory Authority. For example, most of the applications for assistance in the matter of stowing will have to be investigated by the officers of the Mines Department; they will also have to conduct all underground inspections in connection with compulsory sand-stowing and control over depillaring, section-working, etc., and to supervise the operations in connection with fires in closed-down collieries.

(*e*) The work of the Chief Inspector has grown greatly in the last few years and it is considered that a Deputy Chief Inspector is now necessary. This officer would be able to deal with much of the routine work at the head office, deputise for the Chief Inspector when the latter is on tour, assist in the work of the Statutory Authority, and generally relieve the Chief Inspector so that the latter would be freer to deal with the major problems of safety and conservation that must continually arise.

(*f*) With three Circles, there should be not only an Inspector for each, but also two Junior Inspectors and two Assistant Inspectors. The Chief Inspector should determine the responsibilities of these Junior and Assistant Inspectors in the manner described in section 5 of the Indian Mines Act.

288. The surveying staff and the clerical staff of the Mines Department will also have to be increased probably. Additional work is to be undertaken in connection with the surveys of barriers

between mines and the surveying staff will also be required for underground work in connection with compulsory stowing.

289. SALARY OF CHIEF INSPECTOR OF MINES.—We are of opinion also that, considering his great responsibilities, and the greater responsibilities that are to be imposed on him by the proposed legislation and regulations, the pay of the Chief Inspector of Mines should be increased. His maximum pay is now Rs. 2,500 and we think that this should be raised to Rs. 3,000. It is not fitting in our opinion that the head of an all-India Department should be paid less than the Chief Mining Engineer to the Railway Board and various other heads of Departments with no greater responsibilities.

CHAPTER XII.

Changes in the Act and Regulations.

290. THE INDIAN MINES ACT.—We have already remarked on the fact that almost every witness agreed to the so-called " panic " legislation and regulations of 1936 being made permanent. We also suggest that certain amendments should be made in the Act in paragraph 59 of Chapter IV and paragraph 345 of Chapter XIII. Section 19 (1-A) (*a*) only empowers the Chief Inspector of Mines to prohibit the extraction or reduction of pillars under certain circumstances, but does not empower him to require protective measures to be taken where instability of pillars or adequate barriers exist, and safety of life is in danger. We consider that this sub-section should be amended to give the Chief Inspector power to require stowing or other protective measures to be taken to ensure safety either of life or of the underground workings or of the surface on which are situated roads, rivers, large tanks or reservoirs or buildings, not belonging to the mine-owner. On passing such an order on any mine-owner, the Chief Inspector would send a copy of it to the Statutory Authority, and that Authority would then take the necessary action to assist stowing within the limits suggested in Chapter X of our Report. As regards section 19 (1-A) (*b*), this will no longer be necessary if principles of first working are laid down by regulation as suggested in paragraphs 203 to 208 of Chapter IX.

291. THE REGULATIONS.—There are now Permanent, Temporary and Supplementary Regulations, and all these, with the additions and alterations suggested below and in Chapter IX of our Report, should be grouped together into one compact set of permanent regulations arranged under suitable headings or chapters. It may be said that the regulations will become unnecessarily numerous, but we do not share this opinion because there can be little doubt that many accidents in Indian mines have occurred owing to errors of judgment. Such regulations allow less scope for errors of judgment and turn them into infringements of a legal requirement which should be known to the management. In this connection, we may quote also what His Excellency the Governor of Bihar said at the last annual dinner of the Mining and Geological Institute of India:—

> " But I cannot follow you when you protest at the number of sections, regulations and bye-laws applying to the administration of coal mines. For surely at least 90 per cent. of these are superfluous for the mining engineer running his show on proper lines. They cover only procedure that he would adopt in any case. * * * * There may be 153 regulations to which the mines manager must conform, but the Indian Penal Code contains over 500 sections, descriptive of criminal offences and their punishment, to which every one of us here must conform. Yet the normal well-behaved man never has reason to know of their existence."

The same idea has been put in another way by the Chief Inspector of Mines (W. No. 36) in his evidence:—

"The number of orders which it is necessary to issue would be greatly reduced if permanent regulations existed, such as I have suggested in my reply to *Questions 19, 20, 21 and 22*. For example, with such regulations, orders under Section 19 (1-A) would hardly ever be necessary. If such regulations had been framed 10 or 15 years ago, not only would orders under Section 19 (1-A) have been unnecessary, but many of the orders under Section 19 (1) and 19 (2) would also have been unnecessary—*e.g.*, those orders referring to "danger of collapse".

Regulations such as I have suggested are the proper way to tackle dangers. Whenever a possible danger can be guarded against by regulation, that should be the method applied. The primary duty of the Inspectorate in Great Britain, as it should be the primary duty here, is to see that regulations are carried out.

The reason why it is hardly ever necessary to issue orders in Great Britain is that the regulations there cover very fully the known dangers in British mines. The regulations at present in force in this country do not cover all the known dangers nor do they guard against the fundamental cause of bad working. I would plead very strongly for the early introduction of regulations, such as I have suggested in my replies to the various questions, as without them the position of the Inspectorate in this country is an unenviable one. It is, in my opinion, an absurd position at present that so many orders are considered by the Inspectorate to be necessary and the fact that they are deemed necessary cries out for additional regulations which will reduce that necessity very considerably.

I do not suggest that any of the powers under Section 19 (1), (2) and (1-A) should be removed or curtailed. They are all necessary and will be necessary as long as mining goes on, but the necessity for the exercise of them should be reduced to a minimum by the introduction of regulations for known dangers wherever possible."

Regulation 2.—Ventilating district.—The term "ventilating district" is used in *Regulation 125*, in *Temporary Regulation 5* (Notification No. 1055) and in the *Temporary Regulations 11, 13 and 14* of Notification No. M955.

In the British Act a definition is given in Section 122 and, as the term is used in five places in the Regulations under the Indian Mines Act, we recommend that a definition similar to that in the British Act be adopted. That definition is as follows:—

"Ventilating district means any part of a seam having an independent intake airway commencing from a main intake airway and an independent return airway terminating at a main return airway."

Regulation 15.—In our questionnaire, *Question 60* referred to the desirability of requiring surface buildings, etc., to be shown on the plan of underground workings. At present *Regulation 15 (3)* requires the maintenance of a separate tracing of a plan showing all surface features, and *Regulation 15 (2)* requires all railways, roads, rivers, streams and reservoirs to be shown on the underground plan. In a mine in which pillars are being extracted, it is essential in the interests of safety to show on the underground plan, and also on all tracings of the underground plan which are used in the mine, all buildings on the surface.

In *Regulation 15 (2)* we recommend that the word " and " where it occurs between " streams " and " reservoirs " should be deleted and replaced by a comma, and that after the word " reservoirs " should be added " and all surface buildings ".

As all tracings and prints of plans must be certified by a qualified surveyor to be correct copies of the plans from which they are made, all tracings of the underground plan which are used in the mine would therefore show all buildings.

Regulation 25.—We recommend that an addition be made to this regulation to require the manager of a mine to re-authorise all persons, to whom it is necessary to give authorisations, at intervals of 12 months. The ground for this recommendation is that it is often difficult for a manager to produce copies of all authorisations when required, particularly when an authorised person has been employed for many years.

Regulation 53.—In *Question 58* of the General Questionnaire, the question at issue was whether *Regulation 53* should be amended so as to require that the two shafts or outlets to every mine or seam at work should be within the leasehold of the mine or that, if the two outlets are in adjacent mines, the same manager should be in charge of both mines. The Legislative Department of Government of India gave an opinion on the 8th August 1936 that both the outlets need not be within the limits of the mine whatever those limits may be. It was considered sufficient if there are in point of fact such separate outlets to every seam whether within or without such limits. The Chief Inspector considers that it is unsound practice to permit the second outlet of a mine to be in an adjacent colliery unless both outlets are under the control of the same manager.

It is suggested therefore that the following be added as *Regulation 53 (1-A)*:—

> " Such shafts or outlets shall be within the boundaries of the mine. Provided that, where one of the outlets is within the boundaries of an adjoining mine, both mines must be under the jurisdiction of the same manager."

Regulation 70.—It has been suggested to us, and we agree, that a regulation should be issued requiring old workings in gassy mines, and particularly places in which inflammable gas may accumulate, to be examined once a week by a competent person and the results recorded in a book kept at the mine for the purpose.

292. PRECAUTIONS AGAINST COAL-DUST.—We are of opinion that the existing regulations and bye-laws regulating coal-dust should be examined with a view to their consolidation and possibly more stringent application. It is desirable to unify the precautions against coal-dust by suitable regulations, and the various codes of bye-laws which have been introduced at mines should then be withdrawn.

293. Up to the present the bye-laws in force have required the treatment of coal-dust on haulage and tramming roads, travelling roads, airways and working places, but they have not, as a general rule, required treatment of coal-dust within a zone extending from the working-places for a specified distance. The conditions in Indian mines are different to those in the majority of British mines where the longwall system of working is usually adopted, while the roadways connected to working faces are limited in number. The pillar and stall system as practised in India results in many miles of galleries; in some large mines as much as 120 miles of galleries exist, and in these galleries coal-dust is deposited. Although access to extensive areas of pillars and galleries is usually prevented by stoppings built to conduct the ventilation to working parts, the stoppings are usually of flimsy construction and an explosion, even an explosion of small force and extent, would be capable of destroying them; unless the coal-dust in the workings behind the stoppings has been treated, propagation of the explosion by coal-dust through extensive areas of the mine would be likely to ensue.

294. In South Africa, where the general system of working is by pillar and stall, the regulations require that, in every ventilating district of a fiery mine, a protective zone at a distance not exceeding 300 feet from the working face shall be maintained. The protective zone must be safeguarded against explosions by adequate watering or stone-dusting so as to separate effectively the ventilating district from the main return airways, adjacent districts and disused workings. In addition to the protective zone, haulage roads and airways have to be treated in a similar manner. We recommend therefore that, in addition to the treatment of haulage and tramming roads, travelling roads and airways, a protective zone of a prescribed width from any working place should be specified in the proposed regulation. We are also of opinion that the regulations for the treatment of coal-dust which we recommend should require regular and systematic sampling and testing of the dust within the area and the roadways where precautions are prescribed.

295. The proposed regulations should be made applicable to all mines in which the use of safety lamps is required by present *Permanent Regulation 123.*

Regulation 76.—Question 59 of our Questionnaire referred to the desirability of amending *Regulation 76* so as to require mine-owners to make joint surveys of barriers between adjoining mines.

Boundary disputes are common and in many cases the boundaries on the surface are not clearly demarcated. From the point of view

of safety, the position of the boundary is not very material; what is important is the maintenance of a barrier between mines of a suitable thickness. Although *Regulation 76* prescribes that working shall not be conducted within 25 feet of a boundary or a disputed boundary, it is frequently found in practice that connections are made or that a barrier is so attenuated as to be of no value before any dispute over a boundary arises. Our witnesses, without exception, deposed that in the interests of safety joint surveys of the workings on either side of a common boundary should be maintained, and we also consider that this is essential and should be required by regulation.

We, therefore, recommend that *Regulation 76* be amended to require mine-owners working adjacent mines to make joint surveys of the workings on either side of a common barrier and to maintain, up to a date within six months, a correct plan showing the aforesaid workings.

Regulation 80.—This regulation requires that, in seams lying in close proximity to each other the pillars in each seam shall be vertically coincident. We would invite attention to the fact that neither this regulation nor any other requires that barriers in each of such seams shall be vertically coincident. Moreover, the term " in close proximity " has not been defined and we are of the opinion that it would be advantageous to state a distance. We recommend 30 feet as the distance.

The vertical coincidence of barriers in seams lying in close proximity to each other is as important as the vertical coincidence of pillars. We recommend, therefore, that this regulation be amended as follows:—

> *Add* the words " and barriers " after the word " pillar " wherever the latter word occurs. *Delete* the words " in close proximity to " and *substitute* " within 30 feet of ".

Regulation 88.—In the British Mines Act, Section 44 (3) (*f*) requires manholes to be kept white-washed both inside and for a distance of one foot round the aperture. As it is equally necessary in Indian Mines for manholes to be distinctive and readily located, we consider that it is in the interests of safety to add a requirement to this effect to *Regulation 88*. In many mines this safety measure is already being taken. We recommend that the following be added at the end of *Regulation 88*:—

> " and every manhole shall be kept white-washed both inside and for a distance of not less than one foot round the aperture."

Regulation 122.—We recommend that this regulation be amended as follows so as to specify the points at which the monthly measurements of air shall be made. Our recommendation is in accordance with the British Regulations.

(*a*) In the main intake airways of every seam, as near as practicable to the downcast shaft.

(*b*) In every split, as near as practicable to the point where the split commences, and

(c) In each ventilating district, as near as practicable to a point where the air is subdivided at the end of a main split or where it enters the first working place.

Regulation 127.—Examination of safety lamps.—Regulation 127 and Bye-laws 26 and 27 already prescribe the examination and registration of safety lamps before they are taken into a mine, but they do not require any examination to be made when the lamps are returned after use in the mine.

In the British Act, Section 34 (ii) requires an examination to be made when safety lamps are returned and also requires a record to be kept of all damage to safety lamps. Such examination and reporting serves a useful purpose as it is a means of checking misuse and tampering.

We recommend an addition to *Regulation 127* on the following lines:—

> "A competent person appointed in writing by the manager shall examine every safety lamp on its return after use underground and shall record, in a book to be kept at the mine for the purpose, the nature of any damage or misuse found on such examination, and the book shall be sent to the manager on any day when damage or misuse of a safety lamp has been recorded."

Regulation 127.—Searching of persons before entering a mine in which safety lamps are required to be used.—We also recommend that a regulation be introduced requiring the searching of all persons before entering a mine in which safety lamps have to be used. Such a regulation is in force in British mines and we suggest that a regulation on the lines of Section 35 of the British Mines Act, with modifications to suit Indian conditions, be introduced.

Regulation 127.—We recommend that this Regulation be further amended so as to require the manager, or a competent person appointed by him, to examine thoroughly all safety lamps in use at the mine at least once a week, and to record the result of such examination in a book to be kept at the mine for the purpose.

Although the Chief Inspector has advised by circular letter that this action should be taken, we think that it should be required by regulation.

296. NECESSITY OF KEEPING MECHANICAL VENTILATORS WORKING CONTINUOUSLY.—We are of opinion that, where it has been necessary to instal a mechanical ventilator in mines giving off inflammable gas or in which there are underground fires, such machines should ordinarily be kept constantly in operation when persons are at work in the mine. Unavoidable and unexpected stoppages of fans are liable to occur and in some mines, or in certain parts of some mines, danger might arise in a few minutes in the event of such a stoppage, whereas in other mines the danger would be very small even with a stoppage of several hours. It appears, therefore, that it is necessary to have carefully considered standing orders

to deal with the situation at all mines mechanically ventilated. Such standing orders would not be uniform as every case would have to be judged on its merits, and they should be drawn up with the approval of the Chief Inspector.

297. We recommend therefore that a regulation be framed to empower the Chief Inspector to require the introduction of these measures. We have been informed that the Chief Inspector already has under consideration a draft regulation for the purpose.

298. MISCELLANEOUS REGULATIONS.—In the British Mines Act, Section 27 reads as follows:—

> "In every mine (*a*) the materials required for the support of the roofs and sides shall be provided by and at the cost of the owner of the mine, (*b*) and the firemen, examiners or deputies and all other officials of the mine shall be appointed, and their wages paid, by the owner, notwithstanding that the mine or any part thereof is worked, or any part of the operations therein is carried on, by a contractor, (*c*) and no such contractor, nor any person employed by him, shall be appointed to be manager, under-manager, or fireman, examiner, or deputy of the mine."

299. For many years the necessity for such a regulation in the Indian Mines Regulations has been apparent. In many instances mines have been handed over to contractors, called raising contractors or managing contractors, on short term agreements. These agreements vary considerably; in some, the contractor pays the manager and all staff, and purchases at his own expense all perishable stores; in others, only the manager is paid by the owner or the contractor remits the manager's pay to the owner; in others again, the manager and staff are paid by the owner who also provides all stores and materials, while in some the contractor (managing contractor) works the mine as if he were the owner, but the owner usually retains the right of inspection and directs through his agent the laying out and working of the mine.

300. While there is little or no objection to the handing over of a mine to a managing contractor, who is similar to a sub-lessee and virtually the owner of the mine under the Indian Mines Act, and whose agreement requires him to work the mine at his own expense and to pay a commission per ton covering the royalty on coal raised, and the interest on the value of the machinery, shafts, buildings, etc., there is a strong objection to a coal raising contractor who is usually paid a fixed rate per ton of coal loaded into wagons and whose rate may cover the cost of getting and raising coal, maintenance of haulages and tramways, setting of timber and supports, pumping and all supervising staff including even, in some instances, the manager. Such contracts are usually terminable in a short period. It is obvious that it is in the interests of the contractor to raise coal as cheaply and in as large quantities as possible, while the proper and safe working of the mine is of little, if any, importance.

301. In the past the Department of Mines has had occasion to request the owners of mines to amend the terms of agreements with contractors so that the owner can appoint and pay all supervising staff, but such requests have not been supported by the existing law.

302. We strongly recommend that a suitable regulation be incorporated as follows:—

> "In every mine the materials required for the support of the roofs and sides shall be provided by and at the expense of the owner of the mine. The manager and supervising staff, attendance clerks, and all persons employed in connection with the raising and lowering of persons, shall be appointed, and their wages paid, by the owner, notwithstanding that the mine or any part thereof is worked, or any part of the operations therein is carried on, by a contractor, and no such contractor nor any person employed by him, shall be appointed to be the manager."

303. MECHANICAL VENTILATION OF GASSY MINES AND MINES IN WHICH THERE ARE FIRES.—As regards *Question 7* regarding mechanical ventilation, 34 technical witnesses expressed themselves in favour of the legal enforcement of mechanical ventilation, while 6 were against it. Some of those who were against it admitted that they would personally prefer mechanical ventilation when dealing with fires. Others considered mechanical ventilation unnecessary "if the natural ventilation is adequate and properly coursed". It is well-known, however, that natural ventilation varies considerably within 24 hours and at different seasons of the year. There is no control over it and control is essential in dealing with fires. Even if a fire has been sealed off, there is always the possibility of leakage, and there is also the danger of stoppings being blown out by roof falls inside the sealed-off area. Gases are then expelled, and it is essential that the direction in which those gases travel should be controlled. The fan must therefore be exhausting or forcing according to the relative position of the fire area to the working faces and the outlets, the essential point being that gases from a fire area should not be carried on to the working faces. *Regulation 136* requires that every fan should be reversible, and it would therefore be used to exhaust or force in accordance with the circumstances of each case. The main consideration is the safety of the miners.

304. Our recommendation is therefore that the installation of mechanical ventilation should be required by law in all gassy mines and in all mines in which there are sealed-off fire areas. An exception might be made in the case of small mines not raising more than 2,500 tons a month where positive ventilation may be supplied by steam-jets.

305. PROVISION OF TELEPHONES.—In answering *Question 10* of the General Questionnaire, the principal objections made to the compulsory introduction of telephonic communications were that

the telephones would get out of order and that employees would be incapable of using them properly. We were told, however, that, in the Sripur Colliery, telephones of a special mining type had been working satisfactorily for about two years. It is evident also that operators can be easily trained. Other witnesses said that telephones would be useful, but should not be enforced, while others again said that signals in the reverse direction would be better.

306. We do not consider any of these objections conclusive. We were told by one witness (W. No. 24) that, in the case of Joktiabad explosion, he was definitely of opinion that the existence of telephonic communications underground enabled him to arrive much more quickly at the spot than would otherwise have been possible. It is the time element that is of essential importance in getting men out of a mine or dealing with an accident in which persons have been injured. We are of opinion therefore that telephonic communications should be required by regulation in all cases where the distance from the bottom of the shaft or the entrance to the mine to the end of the main haulage road is 3,000 feet or over. This is the distance prescribed in the British Regulations. The Chief Inspector should be empowered to prescribe shorter distances where he considers them necessary, as for example, where the gradient is steep or the seam thin.

307. In mines in which sand-stowing is introduced, telephonic communication between the district in which stowing is being done and the surface, or the control point at the surface, will be necessary.

308. Telephones would be a great asset in the event of fires, enforced stoppage of the fan in gassy mines or other emergencies, for the rapid withdrawal of workers.

309. We recommend therefore that the use of telephones be required by a regulation such as the following:—

> "Where in any mine the distance of the main haulage from the shaft is 3,000 feet or over, efficient means of telephonic communication shall be provided and maintained between a suitable station near the end of the main haulage road and the pit-bottom and the surface.
>
> "Provided that the Chief Inspector may by order in writing require the provision of means of telephonic communication where in any mine the main haulage extends to a distance less than 3,000 feet from the shaft where travelling is unduly arduous."

310. PROVISION OF MEANS FOR DEALING WITH FIRES UNDERGROUND.—We are satisfied that there should be provision in the Regulations for dealing with accidental fires. Whatever the cause of the fire at Loyabad may have been, it is certain that, if means of quenching that fire had been available when the fire first broke out, the disaster would have been avoided. We are therefore of

opinion that there should be a regulation requiring taps to be provided on existing water mains, or other existing pipes containing water under pressure, with distances between the taps equal to twice the length of the hose pipes maintained. Where there are no existing water mains or other pipes, or where water is not available underground, the regulation should require portable water tanks with hand pressure pumps.

311. CERTIFICATION OF SHOT-FIRERS.—The opinion of our witnesses on *Question 30* of the General Questionnaire is practically unanimous that shot-firers should be certificated by examinations (arranged for like other examinations by the Mines Department) after two years' practical experience underground of which at least six months should be experience in connection with shot-firing. All shot-firers should be required to obtain this certificate after examination within two years from the date on which the regulation comes into force. All sirdars should be required, also within two years from the date on which the regulation comes into force, to have their certificates specially endorsed for shot-firing and gas-testing. Both qualifications are increasingly necessary because of the amendments and additions which have already been made in the Permanent, Temporary, and Supplementary Regulations, and which will be made as a result of our suggestions. Sirdars would then be able to fire shots where only a few shots have to be fired now and again. Where a large number of shots have to be fired, the shot-firers for coal-getting would have the special certificates referred to above. Further, all shot-firers should be paid a regular wage and should not be allowed to have any financial interest in coal-getting.

312. As there will be a large number of examinees for endorsements of sirdars' certificates and for shot-firers' certificates, the arrangements for their examination should be put in train as soon as possible after the regulation comes into force and every endeavour should be made to complete the examination of all candidates within the period referred to above.

313. EXPLOSIVES SECTION.—As regards the proposed amendment to *Permanent Regulation 106*, dealt with in *Question 31* of our General Questionnaire, the only questions for decision are:—

(i) Should the 5-lb. limit be altered.

(ii) Should the proviso be retained.

The 5-lb. limit is adequate for normal working purposes. In sinking shafts and stone drifts, or where heavy blasting is necessary, more explosives may be required at a time, and this is what the proviso is intended to cover. It is for special cases and should not be extended to normal working purposes. If retained, however, the proviso should be used where necessary.

The first part of the Regulation should stand as it is. There should then be a proviso that, in sinking shafts, the carrying and use of one canister containing up to 10 lbs. may be permitted.

Then would follow the present proviso which would be specifically applied to underground working only and be worded as follows:—

> " Provided that the Chief Inspector may, in special cases, by order in writing, and subject to such limitations as he may prescribe, permit the carrying underground at one time, and the use at one place underground, of more than 5 lbs. of explosives in one case or canister or otherwise."

A number of our witnesses suggested that canisters or cases in which explosives are carried should be securely locked. We agree with this and recommend an amendment of *Regulation 106* as follows:—

> *Add* the words " and locked " between the words " closed " and " cases ".

It has been suggested that the words " and detonator " should be added in *Regulation 101* after the word " explosive ". We are of opinion that a detonator is an explosive and that the addition is not necessary.

Regulation 102.—One witness suggested that the word " gunpowder " should be replaced by the word " explosives ". We approve of the suggestion because the word " explosives " would include all kinds of explosives. We recommend that the regulation be amended accordingly.

Regulation 107.—One witness suggested the addition of the words " only one description of explosive in any one hole " to this regulation. We have considered this suggestion, but do not think an amendment is justified because the charging of more than one kind of explosive in one shot-hole is extremely unusual and not within our experience in Indian coal mines.

Regulation 108.—It has been suggested that the words " under the personal direction of " where they occur in this regulation should be deleted. We do not approve of the suggestion, but think that the word " supervision " should replace the word " direction ".

Regulation 109.—We have received a copy of a report on a fatal accident at the Upper Ghorawari Colliery and of the correspondence which has passed between the Central Provinces Government and the Chief Inspector regarding this accident. The accident resulted from a miner disregarding the warning of a shot-firer, the miner being killed by coal projected from a shot-hole when he returned to his working place while shots were being fired.

The regulation in force now requires that a person about to fire a shot shall give sufficient warning to all persons likely to be endangered. The instruction prescribed is indefinite as it may be interpreted as only requiring the shot-firer to shout a warning that he is about to fire a shot. In the correspondence relating to the above-quoted accident, the Chief Inspector stated that " there could be no harm in having a regulation which stated that, when shots are to be fired, all persons shall be withdrawn and shall remain at a distance of not less than 250 feet from the place of

shots and in a place which is not in direct line with the shots, but I feel that a greater safeguard lies in insisting on the supervising staff, such as overmen and sirdars, requiring all persons to be withdrawn and seeing that they are withdrawn ".

We have proposed that all shots shall be fired by persons duly qualified and certificated for the purpose. We are not in favour of the distance to which persons shall be withdrawn being specified. The result of certification of shot-firers will be that a better and more responsible type of person will be employed to do this work.

We recommend that *Regulation 109* be amended as follows in general accordance with the British Regulation on the subject:—

> " The person firing the shot shall, before doing so, see that all persons in the vicinity have taken proper shelter at a safe distance; he shall also take suitable steps to prevent any person approaching a shot, and shall also himself take proper shelter."

Regulation 112.—It has been suggested that the words " and a second charge shall not be placed in the same hole ", should be added to this regulation.

We are of opinion that this would be a useful addition and recommend that, at the end of the regulation, the following be added:—" nor shall a second charge be placed in the misfired shot-hole ".

Regulation 113.—One witness suggested an addition to this regulation with reference to sinking shafts. We have carefully considered the suggestion and do not think the addition necessary.

Regulation 114.—It has been suggested that the following addition be made to *Regulation 114;* we recommend it as it follows the British Regulations.

> " and the diameter of every shot-hole shall be such as to allow a clearance of at least $\frac{1}{8}$ inch over the diameter of the cartridge of explosive which it is intended to be used in the shot-hole."

Electrical firing of shots.—We would invite attention to the absence in the Indian Regulations of a regulation prescribing the procedure before firing a shot by electrical means. In the General Regulations under the British Mines Act, the following procedure is prescribed:—

> " Where shots are fired electrically . . . . the authorised person shall not use, for the purpose of firing, a cable which is less than 60 feet in length, he himself shall couple up the cable to the fuse or detonator wires and shall do so before coupling the cable to the firing apparatus, he shall take care to prevent the cable coming into contact with any power or lighting cable, he shall also himself couple the cable to the firing apparatus and before doing so he shall see that all persons in the vicinity have taken proper shelter."

We recommend that a regulation on these lines be added to the Indian regulations governing the use of explosives.

314. EXTENSION OF THE USE OF " PERMITTED " EXPLOSIVES.—In *Question 29* of the general questionnaire, the point was whether the extended use of " permitted " explosives should be required on the lines enforced in British mines. Of the 45 witnesses who replied to this question, 31 were not in favour of such extended use, 12 were in favour of it, and 2 were in favour of the extended use of " permitted " explosives only in dry and dusty mines. Most of those who were not in favour of the extended use of " permitted " explosives objected on the ground of increased cost.

315. The regulations relevant to this question are *Permanent Regulations 115 and 116* and *Supplementary Regulations 3, 4 and 5*. The position at present in Indian coal mines is that the use of " permitted " explosives is necessary only in those mines in which safety lamps are required to be used. In British mines, the use of " permitted " explosives is necessary in all mines in which safety lamps are required to be used and also in any road or any dry and dusty part of all other mines which are not naturally wet throughout. The percentages of the various kinds of explosives used in British and Indian coal mines during 1935 were as follows:—

	British coal mines.	Indian coal mines.
	Per cent.	Per cent.
" Permitted " explosives	72	3
High explosives (not " permitted ") . .	3	3
Gunpowder (not " permitted ") . . .	3	94

316. " Permitted " explosives are explosives which have been tested in the presence of inflammable gas and dry coal-dust, and their use adds very greatly to safety. The enforced use of " permitted " explosives in place of gunpowder would probably add 4 to 6 annas per ton to the cost of producing coal. Over a period of 39 years, no explosion of coal-dust has been caused in India by the use of gunpowder. Further, the introduction of *Supplementary Regulations 4 (ii) and 5* in June 1936 is a great advance in the direction of safety and, if these regulations are strictly observed and enforced, the danger from coal-dust will be very greatly reduced. Although, therefore, we are in favour of and recommend the extended use of " permitted " explosives in all coal mines, we are not prepared to recommend that this extension should be required by regulation.

317. PROVISION OF A STORE-HOUSE FOR UNUSED EXPLOSIVES LEFT OVER AT END OF A RELAY.—The practice at present is for unused explosives brought out of a mine at the end of a relay to be handed over to an attendance clerk when the main magazine is closed after dark. In some instances, explosives have to be taken from a main magazine before dark and some time before a relay commences. Accidents have resulted from explosives being kept in

insecure places and the necessity for providing a small secure store-house near the entrance to a mine has arisen.

318. At mines where explosives are ordinarily used for coal-getting, a small subsidiary store-house, properly constructed and capable of being securely closed and locked, should be provided at a safe distance from the mine entrance so that there would be no difficulty in returning unused explosives at the end of a shift, and in order to minimise the danger of explosives being taken into dwellings or stored in unsafe places.

319. There are already such temporary store-houses at some mines, and no objection has been made to them hitherto under the Government of India Explosives Rules.

320. SUGGESTED AMENDMENTS OF THE TEMPORARY OR SUPPLEMENTARY TEMPORARY REGULATIONS CONTAINED IN NOTIFICATIONS NOS. M955 AND M1055, DATED 23RD MAY 1936, 27TH JUNE 1936 AND 27TH JANUARY 1937 RESPECTIVELY.—*Temporary Regulation 3 —Notification No. M955.*—Some witnesses concerned with small mines which are ventilated by natural means raised the objection that strict compliance with the regulation is difficult owing to the practical impossibility of showing the direction of ventilation in a mine when, during various seasons of the year and certain hours of the day, the ventilation reverses. Although we agree with this argument, we are of opinion that, even in small mines naturally ventilated, such a plan showing the position of doors, sheets and stoppings is of practical value, and it is possible to show on such a plan the course of the ventilation during the major part of the year. We do not think any amendment of the regulation is essential as the present wording " general direction of the air-currents " appears to us to be sufficiently elastic to cover the objection.

Temporary Regulation 4 (1)—Notification No. M955.—It was suggested that the wooden lid on a covering over a working shaft, which is raised by the rope cappel and which must be constructed in a manner and with materials such that it will be readily broken to permit of the safety hook operating, should be exempted from this regulation. We agree with this suggestion and recommend that effect be given to it by amendment of the proviso to the regulation.

It was also suggested that the words " tops of shafts " should be defined. The Chief Inspector has suggested that " tops of shafts " should be defined as the surface superstructure within a distance of 25 feet of the shaft.

We recommend that the regulation be re-worded as follows:—

> " All surface structures and supports within a horizontal distance of 25 feet of the perimeter of shafts, and the covering of all shafts sealed off or covered for ventilation purposes, and all fan drifts, fan casings and parts of fans within such drifts or casings, shall be of non-inflammable material."

Temporary Regulation 4 (3)—Notification No. M955.—Some witnesses suggested that the word " electrical " should be inserted between the words " underground engine house " in this regulation. We do not agree with this suggestion because the danger from fire is almost as great in houses where the engines are driven by air or steam as in those where the motive power is electricity.

Temporary Regulation 6—Notification No. M955.—Some witnesses suggested that other kinds of ashes, such as ashes from open fires in dwellings, should be included and that the word " boiler " before " ashes " should be deleted. We agree with this. They also suggested that the term " any broken surface " in this regulation was not clear and somewhat ambiguous. They suggested that the word " open " should be added before " broken ". Even this addition would not entirely eliminate the ambiguity. We recommend that the latter part of the regulation be amended to read " or on any ground damaged by the extraction of coal in which open fissures or cavities exist ".

Temporary Regulation 7 (2)—Notification No. M955.—The Chief Inspector has suggested that the distance of 20 feet should be increased to 40 or 50 feet. A fire situated at a distance of 20 feet from a downcast shaft is objectionable. We recommend that the distance be increased to 40 feet from the perimeter.

We also recommend that the words " such as repairs or additions to permanent structures which shall be specified in the order " be added after the word " purpose " and that the word " such " shall be replaced by the word " the ".

Temporary Regulation 9—Notification No. M955.—It was suggested by a few witnesses that the word " river " should be defined because in India many rivers and streams are dry during several months of each year, while it is not clear if the word " river " includes streams. We agree and suggest that a definition of " river " be given at the end of the regulation. A definition which suggests itself to us is the following:—

> " River, where used in this regulation, means any natural watercourse, or any diversion of a natural watercourse, in which the quantity of water flowing at any time of the year is such that if it entered a mine it would be a danger to that mine or adjoining mines."

We would also point out that the first part of the regulation prohibits the quarrying of coal from the bed of a river. In some instances the quarrying of coal in the bed of a river should be prohibited, but in others it would not reduce the safety factor or be likely to prove a danger to underground mines. We recommend, therefore, that the regulation be amended so as to give the Chief Inspector the same power to permit the extraction of coal as is given to him in the second part of the regulation.

We also invite attention to the fact that tanks or reservoirs are not included in this regulation nor in Rules 12 to 14 of the Rules issued by the Bengal and Bihar Governments. As large tanks or

reservoirs do exist in the coalfields, and as it is desirable that workings under them should be controlled, we recommend that a further addition be made to this regulation giving the Chief Inspector authority to specify the conditions of mining under them.

Temporary Regulation 10—Notification No. M955.—This regulation requires rewording. In our opinion, the word "excavation" includes the driving of galleries, and it is obvious that this was not the intention when the regulation was drafted. The wording also appeared to some of our witnesses to be ambiguous because it was not clear if the prohibition of pillar extraction in a lower seam is only applicable to the area immediately below the area on fire in the seam above. We would also point out that, if pillar extraction in the lower seam is prohibited only in the area immediately below the same area as is involved by fire in the seam above, the extraction of pillars around the prohibited area in the lower seam might affect the seals round the fire area in the upper seam and extend the danger.

We would also point out that the regulation does not take into account the thickness of strata between the seam which is on fire and the lower seam, and we think that in some cases the thickness of the strata in relation to the thickness of the lower seam should be taken into consideration.

We recommend that the regulation be amended to meet the above objections.

Temporary Regulation 11—Notification No. M955.—We would invite attention to the proviso to this regulation which permits workers to remain for work in all ventilating districts of a mine which are mechanically ventilated other than the ventilating district in which a fire has occurred.

In a gassy mine, the danger of an explosion of inflammable gas while dealing with a fire is very much greater than in a mine in which inflammable gas has never been found, and the danger of such an explosion being propagated throughout the mine by gas and coal-dust is also greater. In our opinion it would not be prudent to allow normal work to be carried on in other ventilating districts of a gassy mine while a fire is being sealed off. We recommend, therefore, that the proviso be amended as follows:—

> "Provided that, in a mine in which the use of safety lamps is not required other than for inspection purposes and which is mechanically ventilated, this regulation shall apply only to the ventilating district or districts that may be affected."

Temporary Regulation 13—Notification No. M955.—Some witnesses suggested that this regulation should be amended so as not to require the use of safety lamps in a ventilating district of a mine in which there is an extinguished fire. We do not think any modification is necessary as the proviso already gives the Chief

Inspector power to grant an exemption where he considers it safe to do so.

321. PRECAUTIONS AGAINST COAL-DUST IN SEAMS LIABLE TO SPONTANEOUS COMBUSTION OR IN WHICH FIRES EXIST.—*Temporary Regulation 14* requires certain precautions to be taken against danger from coal-dust in every ventilating district of a mine which is not naturally wet throughout, and in which there is an underground fire whether the fire is sealed off or not. It is obvious that it is better to take precautions before a fire occurs than after it has occurred. Once a fire or heating takes place, all concerned concentrate their attention on dealing with the fire and the precautions prescribed in this regulation are likely to be overlooked. The consensus of opinion among our witnesses was that this Temporary Regulation should be extended to all mines in which the coal is liable to spontaneous combustion whether there is a fire or not, or whether a fire has ever occurred or not. As most witnesses were also of opinion that no coal is entirely free from the danger of spontaneous combustion under favourable conditions, it follows that the Temporary Regulation should be extended to all mines.

322. We are of opinion, however, that it will be sufficient to restrict the regulation and its proposed extension to districts in which depillaring operations are in hand or are about to commence. Our opinion is that the precautions should be taken before depillaring is actually commenced.

323. We are also of opinion that, in seams of the Barakar series below grade II in quality, the danger from spontaneous combustion is unlikely. We recommend, therefore, that provision should be made in the regulation to allow the Chief Inspector to exempt from the operation of the regulation mines in which he considers the danger of spontaneous combustion very remote.

324. We would also invite attention to the limitations of this regulation requiring the treatment of coal-dust on haulage and tramming roads only. We are of the opinion that the treatment of coal-dust on haulage and tramming roads only will not prove in practice an adequate safeguard. What is equally important is the formation of a protective zone of a suitable width round a fire area or an area in which pillars are being extracted. We recommend, therefore, further amendment of the regulation to require, in a ventilating district not naturally wet throughout, the treatment of coal-dust on haulage and tramming roads and in a protective zone of 400 feet round an area which is sealed off on account of fire or round an area in which pillars are being extracted. Furthermore, the regulation should require periodic sampling and testing of the dust within the area and in the roadways where precautions are prescribed.

Temporary Regulation 15—Notification No. M955.—(*a*) The regulation as it stands only requires the prevention of the passage of air from the mine to the surface, and an amendment to require

the prevention of the passage of air from the surface to a fire area, wherever this is safe and reasonably practicable, appears to be desirable. One or two of the witnesses held the view that the surface should be levelled and blanketted wherever it is broken by the extraction of coal whether fires exist underground or not. This is rather an extreme view and giving effect to it in the Jharia Field would now be almost impossible except at very great expense. We agree, however, that, wherever it is safe and reasonably practicable to prevent air passing from the surface through broken strata to an underground fire, this should be required by regulation.

We recommend an addition as sub-paragraph (*c*) to this regulation as follows:—

> " adequate precautions, wherever they are reasonably practicable and wherever they can be effected reasonably safely, shall be taken to prevent the passage of air from the surface through any goaf or broken strata to a fire."

(*b*) In the report of enquiry into the accident at the Bagdigi Colliery in 1935, a recommendation was made to the effect that adequate precautions should be taken to prevent water from the surface entering a fire area. Effect to this recommendation has not been given in the temporary regulations. It may be argued that *Regulation 73* cover this danger, but we are of opinion that this regulation is intended primarily to prevent danger from inundation of a mine, whereas the amendment proposed is intended as a precaution against quantities of water entering a mine such as would not create a danger of inundation, but which, if passing in or through a fire area, would be likely to cause danger by generation of steam or gases, or by the destruction of stoppings round a fire area. Moreover we have recommended that the regulations which are designed to guard against dangers from any particular cause, such as fires, should be grouped together and it is desirable, therefore, that the precaution should be prescribed in one of the regulations which deals with fires.

We recommend that a further addition be made to *Temporary Regulation 15* and suggest the following as sub-paragraph (*d*):—

> " adequate precautions, wherever such precautions are reasonably practicable, shall be taken to prevent surface water entering a goaf or broken strata which is connected with the fire: Provided that sub-paragraph (*d*) shall not affect the flooding of a mine or part of a mine as provided for in *Regulation 75-A*."

Temporary Regulation 3—Notification No. M1055.—At present this regulation requires the use of " permitted " explosives in any mine where safety lamps are required to be used even for inspection purposes, including the examination of fire stoppings and the examination of workings, after a discontinuance of more than 7 days. The enforcement of the use of " permitted " explosives

where safety lamps are not required to be used throughout the mine or ventilating district does not appear to have been intended when this regulation was introduced.

We recommend an amendment as follows:—

> "In any mine or part of a mine in which safety lamps are required to be used, other than in any mine or part of a mine in which safety lamps are required to be used for purposes of inspection only, by or under any regulations for the time being in force, no shot shall be fired unless the explosive is one of the "permitted" explosives, etc., etc.

Temporary Regulation 5—Notification No. M1055.—We recommend that a relaxation of this regulation should be made in respect of shots fired between relays when only a limited number of persons are present in any ventilating district of a mine. Such a relaxation would tend to encourage the firing of shots between relays, and this is very desirable and would be advantageous in mines where undercutting by machinery or by hand is done. The relaxation would also overcome to a considerable extent the objections to the implications of this regulation which have been brought to our notice by the representatives of mines in the Central Provinces.

We recommend, therefore, that an addition be made to this regulation on the following lines:—

> *Temporary Regulation 5 (d).*—"To any mine in which shots are fired between relays when not more than 50 persons are present in the whole of the underground workings, or not more than 25 persons are present in any ventilating district."
>
> *Supplementary Temporary Regulation 6 as amended by Notification No. M1055, dated 27th January 1937.*—"When inflammable gas or any noxious gas is detected in any working place or any part of a mine, the occurrence shall be immediately reported to the manager, etc., etc."

One witness pointed out that there is an objection to this part of the regulation as the reporting of such an occurrence immediately is not always possible in practice. The fencing-off of a place containing gas is the step which is of first importance. A competent person making an inspection in compliance with *Regulation 70* before the commencement of work may be the only person in a district, and if he finds gas in any place or part of the district he would, in strict compliance with this regulation, have to leave the district, without taking other more important steps, in order to inform the manager. Moreover, the manager might not be present at the mine and some time might elapse before he could be informed. We agree with the desirability of informing the manager without delay, but we think the regulation should be modified to meet the above objection. We understand that the Chief Inspector is submitting to Government a redraft of this regulation which will obviate the objection.

325. ADDITION TO THE MODEL CODE OF BYE-LAWS FOR COAL MINES.—In the British General Regulation, *Regulation No. 38* reads as follows:—

> "He (the manager) shall see that a sufficient supply of proper materials and appliances for the purpose of carrying out the provisions of the Act and ensuring the safety of the mine and the persons employed therein is always provided, and, if he be not the owner or agent of the mine, he shall report in writing to the owner or agent when anything is required for the aforesaid purpose that is not within the scope of his authority to order."

326. For many years it has been a complaint of many managers, particularly of small mines, that the owner or agent would not supply sufficient materials for carrying out the requirements of the Act, Regulations, Rules and Bye-laws. In most cases, however, the manager has been unable or unwilling to provide proof of such negligence on the part of the owner or agent. The inclusion of a bye-law similar to that quoted above would fix the responsibility for negligence in this respect on one person, and it would be a means of impressing their obligations on owners and agents. It is suggested that, in addition to reporting in writing to the owner or agent when anything is required, a copy of such report should be kept by the manager at the mine as proof of such report or requisition having been made.

327. A suitable place for this proposed bye-law would be in the section "Managers" of the model code of bye-laws for coal mines.

328. We would also invite the attention of owners, agents and managers of large mines to the desirability of appointing one or more men, suitably qualified by experience and education, to teach underground workmen and staff safe and proper ways of performing certain duties, to instruct them in the operation and requirements of the regulations, rules and bye-laws, and to bring to the notice of the manager any infringement of the regulations, rules or bye-laws by any person employed underground.

CHAPTER XIII.

Miscellaneous Recommendations.

329. NATIONALISATION.—We have considered generally the alternatives of nationalisation of mines, nationalisation of royalty-rights and nationalisation of undeveloped properties. We are aware in this connection that the French Government has announced its intention of nationalising mines, and that the British Government is considering the nationalisation of royalties. In India, apart from the financial difficulties of any kind of nationalisation, there would evidently be great practical difficulties in valuing properties or royalty rights on account of the very large number of persons interested. A special tribunal would have to be set up to value properties or royalties, and the process would probably not be completed for about 10 years. The serious state of India's coal reserves makes time the essence of the situation and demands that whatever measures of conservation and control are decided on should be put in force as quickly as possible. Further, the fact that, except in Bengal and Bihar, the State already owns the royalty rights over coal deposits has not so far made much difference to wasteful and dangerous methods of working. It has been suggested that, as the State already manages most of the railways adequately, there is no reason why the State should not also manage coal mines, but it seems to us that there is a great difference between running an administrative service and producing commodities or raw materials for sale in a competitive market. Rationalisation is a compromise between State ownership and complete individualism, and rationalisation permits of various kinds and degrees of public co-ordination and control aiming at the best form of efficiency which will benefit both the community and the individuals directly concerned. We therefore consider that, for the present at any rate, rationalisation and control on the lines suggested in our earlier chapters in the wisest policy for India more particularly at the existing stage of her political evolution.

330. CENTRAL MARKETING AGENCY.—One form of rationalisation, which we only referred to incidentally in paragraph 193 of Chapter VIII, is some State-controlled or State-guided central marketing agency covering the production and sale of coal. We have described in Chapter VIII what steps have been taken in this direction in Great Britain and other important coal-producing countries, and we have also indicated in Chapter III that a new spirit of co-operation is required in the coal trade before any similar steps can hope to be successful in India. The psychology of the trade is still too individualistic for concerted action even in its own interests, and we think that, if there is to be any constructive move in this direction, the initiative and guidance will have to come from the Statutory Authority after it has surmounted the initial difficulties of control and conservation. Meanwhile, the Government of India should depute a responsible officer to study the

economic planning which has been attempted in Great Britain and other countries, ascertain how far such schemes have achieved or promise success, and report as to how they could be adapted to Indian conditions. The Statutory Authority should by then have attained such a standing in the Indian coal trade and industry as to be able to direct the necessary propaganda along practical lines. It may thus be possible to establish eventually one or more organizations manned by members of the coal trade and industry, and subject to the general control of the Statutory Authority in the public interest, for the allocation of quota outputs based on ascertained demands, and for the fixing of regional prices based on costs of production and freight rates. We are aware that all this sounds somewhat utopian, but it is not a bad plan sometimes to "hitch your waggon to a star".

331. Amalgamation of Properties.—As has been pointed out in Chapter VIII, the economics of production are definitely in favour of comparatively large mining units, while the English law provides for the compulsory amalgamation of coal properties in the national interest. In Great Britain, the number of coal mines has been steadily reduced from 2,861 in 1927 to 2,075 in 1935, the majority of the mines closed down being small ones. About 90 per cent. of the large output is produced by 150 undertakings operating groups of mines. In Germany, there were 376 mines in 1924 and 224 in 1934. We do not propose that India should go so far because the small producer has his uses and meets a demand which the large producer does not attempt to supply, but we do think that the Statutory Authority should be empowered to arrange the amalgamation of coal properties which are so small or so badly shaped that they cannot be worked with safety or without excessive waste. We visited two lots of collieries in which the conditions are definitely both unsafe and uneconomical. In Appendix D will be found a plan showing how the Tisra mouza in the Jharia Field has been leased out in small strips involving great waste of coal in barriers, increasing the danger of fire spreading from one property to another, and generally making safe and economical working impracticable. The other plan in Appendix C shows this Tisra group and also two other similar groups at Kujama and Jinagora.

332. In such cases, the Statutory Authority should be empowered to arrange voluntary amalgamations if possible and then proceed to compulsory amalgamation if the owners will not come to terms. The Statutory Authority would deal with each case after considering all the factors involved, such as differing royalty rates, way-leave rights, etc., and might, if necessary, form such properties into a limited liability company with proportionate shares allotted to the various owners. No transfer fees should be payable to the landlords and no stamp fees to Government on any document that may have to be executed. If properties are badly shaped, the length of the boundary barriers, and consequently the amount of coal left in those barriers, is unnecessarily great. When properties are small and narrow, it is difficult to prevent boundary barriers becoming so attenuated as to be of little use as a protection

against fire or flood. On the other hand, if the boundary barriers are of the minimum dimensions (25 feet on each side) required by the regulations, the waste of coal is evidently excessive. Some of these small properties cannot even afford to pump and, during the rains when the dip workings are flooded, output can only be maintained by robbing pillars and widening galleries.

333. ADJUSTMENT OF IRREGULAR BOUNDARIES.—Even where properties are comparatively large, their boundaries are often so irregular as to involve excessive waste of coal in barriers. Again, it often happens that exchanges or transfers can be made to conform with geological features determining working conditions such as faults and dykes. Further, in depillaring in a narrow corner of a property, the roof may not be able to break down properly, and a hanging goaf may thus be erected throwing weight on the barrier and producing crushing. Most of the older mineral leaseholds are based on Revenue Survey boundaries which, even on the surface, have been superseded by Settlement boundaries. There is no necessity, however, for underground boundaries to coincide with surface boundaries particularly when the result of rectangular or even regular boundaries would be to enable more coal to be extracted to the advantage of all concerned. Many mine-owners have recognised this and have arranged exchanges of mutual advantage to themselves as lessees only to find that their landlords either decline to consent or demand excessive *salami* or transfer fees. This has happened even when the exchange has been of obvious advantage to the landlords concerned as, for instance, when it enables coal to be worked which would otherwise be left behind and lost for ever. Appendices E and F contain plans of concrete cases. In Appendix E, Colliery B owns 15½ bighas containing 100,000 tons of coal, and Colliery C 245 bighas containing 1,600,000 tons of coal. Neither area can be readily worked from its parent colliery because both are cut off by faults, but can be worked from Colliery A without any additional expenditure or risk. Colliery B has been leased and sub-leased several times and there are thus a large number of interested landlords. It has not been developed, but the negotiations for the transfer of the 15½ bighas have been so protracted that Colliery A has meanwhile reached its boundary and will presently be going back with pillar extraction. Once this happens, the 100,000 tons of coal in the 15½ bighas will be rendered inaccessible as the area cannot be worked by Colliery B even when the latter is developed because the fault is too large to cut through. On the other side, Colliery A and Colliery C belong to the same company, but to different landlords, both of whom are claiming the entire bed of the river forming the boundary between the two collieries. Owing to pillar extraction in Colliery A, it will not be possible to maintain a road into the 245 bighas area for much longer. The coal can, however, be recovered in the distant future from Colliery C, but only at a heavy cost.

334. As regards Appendix F, it shows two areas, one of about 39·1 bighas estimated as containing 290,000 tons of coal and the other of about 84·25 bighas estimated to contain 572,000 tons

of coal. Both areas are within Colliery B, but can be more conveniently and cheaply worked from Colliery A. The superior landlord is the same for both collieries, and he accepted the terms of transfer arranged by the two mine-owners, but the negotiations failed because the intermediate lessees would not consent to the boundary barrier of Colliery B being broken. Colliery A has completed the driving of galleries up to the smaller area and the commencement of depillaring will debar entrance into the area from that colliery. So far as the larger area is concerned, the matter is not so urgent and it has been decided to work it later from new pits.

335. In all such cases, the Statutory Authority should be empowered to adjust irregular boundaries on equitable terms and to transfer areas which cannot be worked from the parent property to an adjoining property from which they can be worked. No transfer fee should be payable to landlords nor any stamp fees to Government on the transfer documents, but the terms should cover royalty, way-leave, etc. If the mine-owners are in agreement as regards terms, and there is no doubt of the advantages from a national standpoint, landlords or intermediate lessees who continue to withhold their consent after full explanation should be treated as in land acquisition cases for public purposes, *i.e.*, the amounts awarded to them should be handed over to the Collector of the district as revenue deposits in their favour.

336. Abandoned Properties.—As as result of an order to stow before or along with depillaring, or an order to stabilise weak workings or workings under a river, an owner may decide that he is unable to continue working with the additional expenditure involved and prefer to close down his mine. The mine would not then be inspected in the usual way and no one would know what was going on inside it. If the pillars seemed likely to collapse before the mine was shut down, collapse would almost certainly occur after it was closed down, and a fire might follow and spread to other neighbouring collieries. The Statutory Authority should be able to take over such abandoned properties on fair terms and either work them itself to meet State Railway or other Government demands for coal, or arrange for them to be worked by some other owner on suitable terms. All working and other expenses incurred by the Statutory Authority would be a first charge on the property and repayment would be taken from the working profits of the property by annual instalments over a period not exceeding 15 years. There will be no question of nationalisation or State acquisition, and the Statutory Authority should ordinarily arrange to dispose of the property outright or lease it.

337. A similar procedure will be necessary if the Statutory Authority is to deal satisfactorily with the existing fires in closed-down mines as has been suggested in paragraph 250 of Chapter X and paragraph 273 of Chapter XI. Such a property has no market value at the moment, but might contain workable areas or seams after the fire has been extinguished or successfully isolated. All expenditure incurred by the Statutory Authority out of the cess funds,

which would ordinarily be paid by the mine-owner, should therefore be recoverable from the property as a first charge. The landlord or the mine-owner, or both, should be legally required to refund, or undertake to refund within a reasonable period depending on the future expected life of the property, all such expenses before permission is given to work. Failing this, the Statutory Authority should be empowered to dispose of the property to the best advantage, recoup its expenses, and deposit the balance with the Collector of the district in favour of all the interested parties, leaving them to obtain an order from a court as to their respective shares of such surplus amount. If the property has no value after the fire has been dealt with, the expense incurred by the Statutory Authority would have to be borne by the cess funds.

338. Utilisation of Inferior Coal.—It is evident that, if inferior coal (grade II and grade III) could be used for purposes for which superior coal (selected and grade I) is now used, the life of the available reserves of superior coal would be increased. Apart from organised research into such possibilities, there is one way in which the Government of India can now contribute towards this end. If a policy of conservation of good quality coal is definitely adopted, Government must be consistent in its application. If Government introduces our suggested measures of control in the interests of safety and conservation, it should also assist conservation as regards the utilisation of coal by agencies under its control. We have been told that the Great Indian Peninsula Railway has adapted its locomotives to use Central Provinces coal which is not better than grade III in quality, and the figures given in the *Note on Coal Conservation* with the evidence of the Chief Mining Engineer to the Railway Board (W. No. 37) show that the Great Indian Peninsula Railway actually used in 1935-36 and 1936-37 the following quantities of superior and inferior coals:—

	Selected and grade I.	Grades II and III.	Total.
	Tons.	Tons.	Tons.
1935-36 . .	363,000	468,000	831,000
1936-37 . .	350,000	454,000	804,000

If the Great Indian Peninsula Railway can do this, the East Indian Railway might be required to do the same on, at any rate, that part of its line which is near the Bengal and Bihar Fields. The East Indian Railway belongs to the State, but the Bengal-Nagpur Railway does not. The latter does, however, obtain its coal requirements sometimes through the Chief Mining Engineer to the Railway Board, and there seems to be no good reason why it should not use inferior coal in the vicinity of the Bengal and Bihar Fields more especially as it already uses such coal in the Central Provinces and from its own collieries in Karanpura and Talchir. The Bengal-Nagpur Railway witness (W. No. 67) admitted that his railway uses such coal, and we have been shown the following copy of a letter (No. A. 1354 of the 25th July 1934).

from the Agent of the Bengal-Nagpur Railway to the proprietor of the East Barkuhi Colliery in the Pench Valley:—

> "With reference to the correspondence leading to your . . . letter No. 1618, dated the 9th July 1934, I beg to inform you that, from a report received from the Chief Mechanical Engineer, Bengal-Nagpur Railway, Kharagpur, I find that the recent trials made with the steam coal supplied from your East Barkuhi Colliery has proved satisfactory, and that the coal is certified to be suitable for both goods and passenger engines."

We have been informed that it would not be economical to carry coal with a high percentage of ash for the use of railways at any great distance from the sources of production, but we have also been told by the Agent to the East Indian Railway (W. No. 66) that some of that Railway's new locomotives are designed to burn comparatively inferior coal and that there are certain kinds of running in which such coal is more efficient than a high grade coal. Though it is not recorded in his evidence, the Agent said that superior quality coal was really only necessary on trains in which quick acceleration was essential. It should be remembered also that, during the boom period, coal with over 20 per cent. ash was used freely, and one witness (W. No. 35) has told us that a pilot vessel once had difficulty in getting up steam at sea because of the inferior quality of coal that had been supplied to it.

339. A further point in this connection links the more extended use of inferior coal on certain railways with the control of section-working by the Statutory Authority. If the Statutory Authority is empowered to direct in such cases that such coal should be recovered and not left in the goaf and wasted, it would be a good plan to require also that the Statutory Authority should give the involuntary producers of such coal every assistance in disposing of it. A certain amount could be used for the manufacture of soft coke, but the demand for soft coke is limited and it would probably be necessary also to say that such railways as were using comparatively inferior coal should give preference in the matter of contracts to those mine-owners who had been directed by the Statutory Authority to work such coal. It would be understood of course that the preference would only operate where other things were equal in the matter of price.

340. RESEARCH.—This subject is not included in our terms of reference, but it is obviously connected both with safety and conservation, and we have therefore looked into it incidentally. There is already provision in India, financed in various ways, for chemical, industrial, forestry, agricultural and lac research, but nothing has hitherto been done in this direction in connection with coal though over 23 million tons are produced annually with a pitmouth value of over 4½ million pounds. Most other important coal-producing countries have recognised the value of research. The Fuel Research Board in Great Britain spends over £100,000 a year, and there is also a Safety in Mines Research Board. The United States of America spends between 4 and 5 hundred thousand

dollars on fuel research and safety for the benefit of the coal industry, and there are similar organisations in Germany, France and Japan, each working on its own local problems and contributing also to the mining knowledge of the whole world. India stands alone in doing nothing as regards coal research even for her own benefit.

341. Research endeavours by scientific study not only to discover new facts, but also to apply such facts practically. Research is both a concomitant and complement of conservation. As a result of research, the same quantity of raw material has been made to produce more finished products; for example in Great Britain, according to Paper No. 4A, Section II, presented to the Third World Conference at Washington in 1936, the yield of gas per ton of coal carbonised is more than one-third greater than it was in 1907, nearly as many units of electricity are now produced from one ton of coal as were produced from $2\frac{1}{2}$ tons of coal in 1921, railways have economised in the use of coal up to 20 or 25 per cent. since 1920, and the iron and steel industry now uses one ton of coal for the purposes for which it used $1\frac{1}{2}$ tons in 1920. It should be remembered also that coal is no longer just a fuel, but has become an essential raw material of various manufactures. It is, for instance, the foundation of the modern coal-tar industry, the diverse products of which include medicines, insecticides, perfumes and high explosives.

342. A certain amount of research has been done by firms like Messrs. Tata and Sons and Messrs. Bird & Co., but we are definitely of opinion that much more is required not only from industrialists, but also under State control and guidance for the benefit of all concerned. A large number of suitable subjects may be suggested such as pulverised or colloidal fuel, hydrogenation, cleaning and preparation of coal, mixing and blending of coals, classification of coal according to quality and specification according to use, more efficient soft coke manufacture, better recovery of bye-products, low temperature carbonisation, making of briquettes, conversion of non-coking into coking coal, coking index, fusion point of ash, analysis of mining costs, labour-saving mechanical devices, ventilation, illumination, and the welfare, education and recreation of those employed in the mines.

343. We recommend therefore that a Coal Research Board should be set up. The initial capital expenditure on buildings and equipment, and half the recurring expenditure on staff, etc., should be met by Government, the other half of the recurring expenditure being paid out of the cess funds by the Statutory Authority. The Coal Research Board should be under the Statutory Authority and should be located on a site in the Raniganj or Jharia Field selected with due regard to water supply and cheap power. The staff should be whole-time and distinct from the staff of any existing institution.

344. Manufacture of Benzol.—About one gallon of benzol is recoverable as a bye-product from every ton of coal used in the manufacture of metallurgical coke. Added to petrol, benzol

improves the octane or anti-knock value, but it is not recovered now because it is subject to the petrol tax of 10 annas a gallon and cannot compete with petrol produced from oil. This valuable bye-product of coal is therefore wasted at present. In Great Britain, the British Hydrocarbon Oils Production Act of 1934 (24, Geo. 5, Ch. 4) allows for nine years, or until the 31st March 1944, a preference of 4 pence per gallon in respect of light hydrocarbon oils manufactured in the United Kingdom from coal, shale or peat indigenous to the country. As the world supply of oil is very limited, and as India has very small oil reserves now that Burma has been separated, it might be considered whether some similar preference should not be given in India to encourage the manufacture of motor spirit from coal. A special plant has to be installed in order to recover the benzol, and the coke oven manufacturers are not prepared to incur the necessary capital charges unless they see a reasonable prospect of a fair return especially as they have already lost considerable sums on plants installed for the manufacture of sulphuric acid and the recovery of sulphate of ammonia.

345. Appeals under the Indian Mines Act.—Several witnesses expressed dissatisfaction with the present constitution of Committees under Section 11 of the Indian Mines Act to hear appeals under Section 19 (5) of the Act. Some of us think that it would be a sound plan to let the proposed Statutory Authority hear such appeals, the Chief Inspector of Mines being of course excluded from the Statutory Authority when it sits in an appellate capacity. This would substitute a permanent tribunal for *ad hoc* committees, and would make for continuity of policy and interpretation of the law. The Chief Inspector of Mines does not approve of this, however, and we have therefore decided to recommend that the constitution of Committees under Section 11 should be altered so as to allow of more technically qualified members. We see no reason why the Mines Department should not be represented on such a Committee if one member is to be a person nominated by the owner, agent or manager of the mine concerned in the order appealed against. Nor is there any necessity for a member to represent the interests of the persons employed in the mine. We recommend that the Committees under Section 11 should be called Appellate Tribunals in future, and should consist of a Chairman nominated by Government, a representative of the Mines Department nominated by the Chief Inspector of Mines, and three mining engineers nominated by the Government of India one of whom will be suggested by the appellant. The decisions of such a tribunal should be final and should not be subject to review by Government except on a point of law.

346. Freight Rates from the Raniganj Field.—At present railway freights to Calcutta from all collieries in the Jharia Field are the same whether by the East Indian Railway or the Bengal-Nagpur Railway. In the Raniganj Field, however, freight is paid according to distance and varies from about Rs. 3-5-6 to Rs. 3-14-6 a ton. This often places a colliery at a competitive disadvantage

with another colliery producing the same quality coal, and we recommend therefore that the application of the group system to the Raniganj Field should be reconsidered. There would probably have to be at least three groups in the Raniganj Field, but the principle of regional internal freights to ensure equal competition is more usually followed in other countries than otherwise.

347. Rescue Stations and Breathing Apparatus.—All our technical witnesses were unanimously in favour of the staff at central mine rescue stations in the major coalfields being trained in methods of dealing with underground fires and the dangers arising therefrom in addition to their ordinary training in rescue work. The Chief Inspector of Mines told us that it was at present proposed to establish two central rescue stations, one at a suitable centre in the Jharia Field, and the other in the Raniganj Field. A scheme has been drawn up on the lines of the British Regulations with necessary modifications to suit Indian conditions, and has already been submitted to the Government of India. We think this scheme should be introduced and that it will be a satisfactory basis from which to commence coal mine rescue work in India.

348. Gas Masks or Self-rescue Apparatus.—If fully-trained central rescue stations with necessary apparatus are established as above, we think it unnecessary to require in addition that gas masks or self-rescue apparatus should be kept at the mines, more especially as there is no such legal requirement under the British Regulations. We are nevertheless of the opinion that gas masks or self-rescue apparatus kept at the collieries might be very useful in certain circumstances, but we do not think that they should be legally required and would leave this to the owners to decide for themselves in the circumstances of each case. If, however, such gas masks or self-rescue apparatus are kept at collieries, we would strongly advise that they should not be allowed to be used by anyone except men who have been trained in their use and understand their limitations, and also that every precaution should be taken to see that the apparatus is always in good working order.

349. Ambulance and first aid work.—Section 18 of the Indian Mines Act has been applied to all coal mines by Bihar and Orissa Notification No. 129 of the 14th June 1925 and by Bengal Notification No. 4425-Com. of the 17th June 1925. In Chapter II of the " Rules for coal mines " the following provisions have been made:—

(i) It shall be the duty of the owner, agent and manager of a mine to see that adequate arrangements are made for the training of men in ambulance work.

(ii) In every mine in which fifty persons or more are employed underground during any period of 24 hours, one or more of the persons employed according to the sub-joined scale shall be trained in ambulance work to the standard of St. John's First Aid Certificate. (The scale then follows and is one trained person to every 100 persons employed underground during any period of 24 hours.)

(iii) In or at every mine in respect of which Section 18 of the Act applies, there shall be provided and kept in good condition and ready for immediate use at a convenient place on the surface and also, if the Chief Inspector by an order in writing so directs in the case of any mine, underground—

(*a*) a suitably constructed stretcher or stretchers; and

(*b*) a box or boxes containing a sufficient supply of suitable splints and bandages, adhesive plaster, boric vaseline, cotton wool and tincture of iodine or other suitable antiseptic solution.

We would suggest the following additional provisions:—

(i) At present, there is nothing which requires mine employees who have been trained in first aid work to keep their knowledge more or less up-to-date. Ambulance competitions have been arranged in the Raniganj coalfield, but no such arrangements have been made in the Jharia coalfield. We consider that the rules should require that every mine employee with a first aid certificate should be required to have a refresher course and to come up for re-examination and renewal of the certificate every five years.

(ii) We would also require that every member of the supervising staff working underground should also be required to have a St. John first aid certificate within a reasonable period, say, 2 years from the date when the new rule is introduced. It should be understood of course that the work of training the staff should be commenced at once.

(iii) We would also suggest that there should be at least one stretcher and first aid box for every 100 persons working in the mine, these appliances to be kept underground at suitable places in the various working sections of the mine.

350. Payment of Wages Act.—This Government of India Act (IV of 1936) was applied in the first instance to factories and railways, but may be extended by Local Government notification to any industrial establishment. Under Section 2 (ii) (*d*) a mine or quarry is an industrial establishment. The coal trade and industry has been consulted regarding the extension of the Act to coal workings, but no action has been taken yet by the Governments of Bengal and Bihar.

351. The principal provisions of this Act are those which fix the kinds of deductions that can be made from wages, prescribe a procedure for imposing fines, and lay down that the total fines imposed in any wage-period shall not exceed half-an-anna in the rupee of the wages payable for that period. It is this last limitation that is considered inadequate as a disciplinary measure in coal mining. It is felt that safety in mines is so important, while acts or omissions in connection with safety regulations may have such serious consequences, that the management should be able to inflict fines heavy enough to act as a real deterrent. Tampering with a

safety lamp in a gassy mine may, for instance, involve many human lives, while failure to attach a drag or back-stay to an ascending train of tubs may have disastrous results. It has been suggested therefore that the extension of the Act to coal mines should be postponed or that the maximum fine should be increased to one day's wages. We think that the matter should be further considered before any decision is taken. The effect of our Report will be to tighten up safety regulations and managers will need every support in carrying out their difficult duties and responsibilities.

352. EDUCATION.—There are Government institutions in the coalfields for training sirdars, overmen, managers and mining engineers, but the education of the labour force has been more or less neglected. In 1935, the average number of persons employed daily in coal-mining was 179,152 of whom 128,041 or 71·5 per cent. worked underground. Most of this labour is drawn from the districts around the coalfields and consists of illiterate and ignorant cultivators. State control and comprehensive regulations will not achieve their best results unless miners are also educated sufficiently to realise the necessity for obeying such control and observing such regulations. No miner should be so unenlightened as not to know the foolishness and danger of piercing the top of a flame safety lamp with a pick in order to improve illumination. If he knew such things, he would be less of a danger to himself and other miners, and more of an asset to his employer.

353. Compulsory primary education is gradually extending and we think that, in Bengal, the Primary Education Act should be extended to the Asansol Subdivision of the Burdwan district as soon as possible. At Giridih, young boys selected from the primary schools are trained in the essential technicalities of mining at a school maintained by the State Collieries. These young men receive a sound training and are fit to be employed in comparatively responsible positions.

354. If there were more primary schools conducted properly and adequately staffed, the children of the miners would receive elementary education in which the syllabus could be made to cover practical instruction in mining and its dangers. Adult labour could be provided for on the same lines as are followed successfully in the United States of America with Negro miners, namely, lectures, demonstrations, lantern slides and cinema films combining recreation with enlightenment.

355. Each coalfield should be divided into groups of collieries, meeting places and demonstrators being provided for each group. Films and slides would be obtained from the United States or elsewhere at first, but could be manufactured in India later, the main object being to illustrate typical mining conditions and demonstrate how accidents could be avoided or prevented.

356. The Statutory Authority might function as a kind of Mining Education Board and obtain the necessary funds partly from the Government, partly from local authorities such as District Boards, and partly from the cess funds.

CHAPTER XIV.

The Central Provinces Coalfields.

357. Pench Valley Fields.—The discovery of coal in the Pench Valley is credited to Dr. Jerdon and Lieutenant R. H. Sankey who visited the area in 1852. The first geological traverse was made in 1856 by Mr. J. G. Medlicott. Various surveys of the field have been made since that date, the most recent being that made between 1923 and 1925 by Dr. C. S. Fox and Mr. W. D. West. Coal mining was commenced in a small way in 1866 when a mine was opened at Barkuhi. The most important company at work is managed by Messrs. Shaw Wallace & Co. of Calcutta, to whose efforts the development of this area, especially in the early days of the present century, is largely due. The Bengal-Nagpur Railway extended their narrow-gauge line from Chhindwara to Barkuhi in 1905, and the first large colliery was opened at Chandameta the same year. In 1912, the Bengal-Nagpur Railway opened a line connecting Nagpur and Chhindwara, and in 1915 the Great Indian Peninsular Railway extended their broad-gauge line from Amla to Parasia. The output was 1,104 tons in 1905; by 1915 it had reached 100,000 tons, and between 1926 and 1935 it increased steadily from 416,708 to over 1·2 million tons.

358. Wardha Valley Fields.—It is believed that coal was first discovered in this area in 1831, but mining was not commenced until 1870 when the Ghugus Colliery was opened. About 1873, after it had been decided to abandon the mine at Ghugus, an important colliery was established at Warora by the Great Indian Peninsular Railway. The output of this colliery increased from 54 tons in 1874 to 153,336 tons in 1902. The mine was abandoned in 1906 owing to subsidence and fire. This action had been anticipated, and coal having been proved at Ballarpur in 1900 by boring, followed by shafts in 1903, operations were transferred to that locality. The Ballarpur collieries are now being worked by a private firm established mainly by the enterprise of Sir Maneckji B. Dadabhoy. In addition to the collieries now working at Ballarpur and Sasti, the Ghugus area has been worked by the same company who have also opened a new colliery at Rajur. A number of small mines have also been worked near Chanda town at Mahakali, Babupet and Lalpet. The output in 1935 from all mines in this area was 312,591 tons.

359. Ownership and Leases.—All mineral rights in the Central Provinces are vested in the Local Government. Coal-mining leases are executed in a standard form which contains *inter alia* clauses requiring (*a*) the payment of a half-yearly minimum rent or royalty, (*b*) a royalty at the rate of 5 per cent. of the pitmouth value, or two annas per ton whichever is greater, of all coal, and 2½ per cent. of the pitmouth value, or one anna per ton whichever is greater, of all coal dust, (*c*) a rent for all surface occupied or used, (*d*) the starting of mining operations within one year, (*e*) development in a skilful and workmanlike manner and upon the most approved principles,

(*f*) the extension of workings on the strike not to exceed twice the extension of workings to the dip, (*g*) facilities for examination, inspection and measurement to agents, servants and workmen authorized by the Local Government, and (*h*) no mining operations or workings within a distance of 50 yards from any railway, reservoir, canal or other public works without the previous permission of the Local Government.

360. THICKNESS OF SEAMS AND NATURE OF COAL.—In the Pench Valley, though several seams occur, only four are of workable thickness, while of these only the top seam is worked at present. This seam is known as the Pench or Main seam. The thickness of the section worked varies from 4 to 8 feet, above it being a varying thickness of poor quality coal with intercalated bands of shale. An average analysis of the section worked is moisture 6·49 per cent., volatile matter 27·25 per cent., fixed carbon 46·49 per cent., ash 19·77 per cent., and calorific value from 5,468 to 6,224. In the Kanhan Valley area, the workable section of the main seam varies from 8 to 14 feet in thickness and an average analysis is moisture 3·02 per cent., volatile matter 29·33 per cent., fixed carbon 46·69 per cent., ash 20·96 per cent. and calorific value from 5,226 to 6,515.

361. In the Wardha Valley there is only one seam containing coal of commercial or industrial value. This seam varies in thickness from 50 to 80 feet. At the Ghugus Colliery, only 10 feet at the bottom of the seam is workable, while at Ballarpur two sections, 14 and 10 feet thick respectively, have been worked, and there are also two other sections about 5 feet thick which are said to be of good quality. An average analysis of the coal worked at Ballarpur shows, moisture 9·88 per cent., volatile matter 33·67 per cent., fixed carbon 46·26 per cent., ash 14·99 per cent., and calorific value 6,200.

362. The coal rapidly disintegrates by weathering when brought to the surface and cannot be stacked for long. We are told that, where reserve supplies have to be kept in hand, these have to consist of better quality Bengal coal. As the moisture content is very high, the coal is extremely prone to fire spontaneously. A pile not more than 2 feet high is said to have fired spontaneously on the surface in the course of a few weeks.

363. OUTPUT.—The annual output from all mines in the Central Provinces has been as follows:—

	Tons.		Tons.
1920	491,205	1929	882,331
1921	712,914	1930	952,371
1922	675,916	1931	973,040
1923	548,074	1932	1,049,238
1924	679,081	1933	1,234,513
1925	708,554	1934	1,438,980
1926	635,252	1935	1,526,690
1927	666,758	1936	1,505,608
1928	732,353		

These figures show that there was no appreciable increase in production between 1921 and 1928; from 1928 onwards, output increased steadily by about 100,000 tons a year, the output in 1936 being more than double that of 1928. This increase has been due principally to demand from the G. I. P. and B. N. Railways, and from the mills in Bombay and Ahmedabad, following modifications of fire-boxes and grates of boilers so that advantage could be taken of this coal which is poor in quality but cheap as compared with more distant sources.

364. METHODS OF WORKING.—In the Pench Valley, where the section worked seldom exceeds 8 feet in thickness, and only one seam or section of a seam is exploited, the pillar and stall method has been adopted. In the Wardha Valley, where the section worked is of greater thickness, while in some mines more than one section is exploited, the panel system has been more generally used.

365. In the Pench Valley the depth of the seam from the surface seldom exceeds 300 feet, the coal is hard and tough, the roof conditions are generally good, and it has been customary to extract more than 50 per cent. of the seam in first working. Practically all the coal is got with explosives. In the Wardha Valley the coal is equally hard and tough and fairly good roof conditions usually prevail, but a lower percentage has been extracted in first working.

366. LOSSES BY COLLAPSES AND FIRES.—In the Pench Valley mines, few fires have occurred though a considerable amount of coal has been obtained from the extraction of pillars. The quantity of coal lost by premature collapses and fires has been very small.

367. As regards the Wardha Valley mines, only one of the mines now being worked has attempted pillar extraction, and hydraulic sand-stowing simultaneously with depillaring has been done there to prevent fires and preserve the superincumbent strata intact. As the coal usually contains more than 10 per cent. of moisture, it is extremely liable to spontaneous combustion.

368. In the Warora Colliery which, as stated above, was commenced in 1873 and worked until 1906, premature collapses and fires did occur. In this mine two seams, 12 to 14 feet thick and separated by shale varying from a few inches to 14 feet in thickness, were worked upon the pillar and stall system. The pillars were irregular in shape and size, the parting left between the workings in the two seams was too thin, coincidence of pillars and galleries in the two seams was not maintained throughout the mine, and the pillars in large areas were split, with the result that the workings became unstable and premature collapses and fires necessitated the abandonment of the mine. It was estimated that, out of 12 million tons of coal in the area exploited, only 3,086,220 tons were recovered, the remaining 75 per cent. of the workable coal being entirely lost.

369. PROBABLE LOSSES IN FUTURE WORKING.—In the Pench Valley mines, conditions are favourable to efficient mining and heavy losses of coal should not occur even with ordinary methods conducted in a systematic and workmanlike manner. In one mine

visited by us, workings had been done in anything but a systematic and workmanlike manner, pillars had been robbed and galleries widened to such an extent as to induce heavy falls of roof rendering the coal left in the pillars inaccessible. A certain amount of coal in pillars supporting the Great Indian Peninsula Railway line has already been lost, and more is likely to be lost, unless the line is diverted to allow of pillars being extracted, or unless the pillars are replaced by solid stowing. We think that diversions of the line would be feasible and would be less expensive than stowing.

370. In the Wardha Valley conditions are very different. In addition to the coal being extremely prone to spontaneous combustion on account of its high moisture content, heavily-watered strata lie above the main seam in the Chanda district; if these strata are disturbed by pillar extraction by ordinary methods, either the mine will be flooded or such heavy pumping will be caused as to render further working an uneconomical proposition. Besides, at the Ballarpur Colliery there are no less than four workable sections in the main seam, and the recovery of a reasonable percentage of the coal in pillars is only possible with stowing. Moreover, at this colliery the whole of the considerable area exploited is either under the Wardha River or under land which is covered by water when the river is in flood. For this reason also the extraction of pillars without stowing is out of the question.

371. NESESSITY FOR STOWING.—All the witnesses examined at Chanda were quite definitely of the opinion that the pillars in the mines in that district could not be extracted without stowing, and one (W. No. 53) said that without stowing it would be necessary to leave from 40 per cent. of the coal in the rise workings to 60 per cent. in the dip workings. The conditions described above render the extraction of pillars without stowing dangerous both to life and to property. We therefore recommend the enforcement of stowing simultaneously with the extraction of pillars in the mines in the Chanda district in the Wardha Valley area.

372. All the witnesses examined at Parasia in the Pench Valley were of opinion that the enforcement of stowing was unnecessary and we agree with them so far as ordinary working is concerned. If the mines are laid out and worked in a systematic and workmanlike manner, the extraction of a high percentage of the coal is possible without stowing. Stowing will, however, be necessary even in the Pench Valley to recover coal under railway lines, buildings and other surface features for which support has now to be left.

373. NECESSITY FOR CONTROLLING MINING METHODS.—Control over mining methods is as necessary in the Central Provinces as it is elsewhere. One of the mines in the Pench Valley visited by us was in a deplorable state due to unscrupulous pillar-robbing, while it is known that serious losses of coal occurred at the Warora Colliery owing to improper methods of working. In the past the Local Government, as owner and lessor of the minerals, has not exercised

any real control over mining methods nor employed a competent mining engineer to enforce the proper observance of the terms of its leases. The inspections made by the officers of the Mines Department have been almost entirely concerned with safety of life, and in only two special cases has the advice of the Mines Department been asked for by the Local Government on questions of economical extraction or the proper working of the mines. Inspections have been made by District Officers, but these inspections have been necessarily concerned with health and questions connected with rents, royalties and boundaries, these officers not being qualified to inspect or advise as regards methods of working or economical extraction.

374. The reply (W. No. 47) of the Local Government to *Question 54* of our general questionnaire was as follows:—

> "Statutory control of mining methods in the interest of both safety and conservation should be universal, but the regulations should be adapted to the particular field to which they apply and not made of universal application all over India. This Government considers that regular inspection of all coal mines, with a view to ensuring that the method of extraction is economical and that no considerable supplies of coal are wasted, is essential in the interest of Government and is second only to inspection for the purpose of ensuring the health and safety of labour."

In our General Questionnaire, *Questions 19, 20 and 21* dealt with the desirability of prescribing general principles of first working, and the prohibition of splitting or reduction of pillars and heightening of galleries beyond the prescribed limits until immediately before systematic pillar extraction. With two exceptions, the mining engineers in the Central Provinces who submitted written replies to our questionnaire did not approve of principles being prescribed or restrictions being imposed by regulation. After discussion with the Committee, all these witnesses agreed that general principles of first working should be prescribed by regulation, and agreed also that the malpractices referred to in *Question 21* should be prohibited on the general lines laid down by us in Chapter IX.

375. The replies to *Question 39* of our general questionnaire, which dealt with the desirability of enforcing a system of packing or stowing simultaneously with the extraction of pillars, showed that all the witnesses working in the Chanda district mines were in favour of such enforcement, while the witnesses concerned with mines in the Pench Valley were not in favour of any such action being taken. As already stated, we are of opinion that the enforcement of stowing simultaneously with pillar extraction is necessary in the Chanda area of the Wardha Valley, but is not generally necessary in the Pench Valley.

376. NATURE OF CONTROL.—In addition to control over first working, further control is necessary in the interests of conservation of a national asset. With one exception the witnesses concerned with mines in the Pench Valley stated that any further control,

beyond that now exercised by the Mines Department, was unnecessary, while those connected with mines in the Chanda district were entirely in favour of statutory control over mining methods in order to ensure conservation, and were in favour of such statutory control being universal. The reply of the Central Provinces Government was also favourable to the introduction of statutory control to prevent wasteful methods, and it is obviously in the interest of that Government as a mineral owner and lessor to support measures designed to secure more economical extraction of coal.

377. The control which we have suggested by the Statutory Authority in Chapter XI would not interfere seriously with present methods in the Pench Valley nor would that control be any handicap to those working their mines in a proper manner. Fires are as likely to occur in the Pench Valley as in the majority of mines in other parts of India, and some measure of control at the time of pillar extraction to prevent the spread of fire from one part of a mine to other parts is equally necessary there.

378. The Statutory Authority would have powers to prohibit wasteful methods of mining and to require measures to minimise avoidable loss of coal. We have recommended that the staff of the Mines Department should be increased and that the officers of that Department should be responsible for all underground inspections in connection with the functions of the Statutory Authority. Any operation or practice likely to lead to undue waste of coal of commercial or industrial value observed during inspections of the Mines Department officers would be reported to the Statutory Authority for consideration and action. The case for the appointment of a Statutory Authority has been fully argued in previous chapters, and the arguments used there are equally pertinent to the Central Provinces mines. In addition, the Central Provinces Government should arrange with the Government of India for the inspection of its mines by the Mines Department with reference to the terms in its leases regarding methods of working.

379. Applicability of the General Cess to Central Provinces.—Three or four witnesses connected with mines in the Pench Valley were opposed to the proposed general cess on all coal and coke despatched by rail in or into British India for the purpose of financing stowing, research and conservation generally. The representatives of mines in the Chanda district were, without exception, in favour of a general cess for these purposes. The Central Provinces Government was opposed to the cess on the following grounds:—

> "... neither logic nor justice demands that the cess should be collected from collieries which do not stand in need of sand-stowing in the interest of either safety or conservation or both. The Government recognises that in certain classes of mines, particularly in the Chanda coalfield, sand-stowing will probably be necessary in the interest of both safety and conservation, but it can see no justification for their recouping part of the expenditure from collieries in other coalfields, as

for instance, the Pench Valley coalfield, where admittedly parallel conditions do not exist. National interests no doubt demand that both safety and conservation should be provided for when a coal mine is worked. But the application of compulsory measures intended to ensure these cannot be regarded by any mine-owner as an abnormal restriction that would give him the claim to compensation for part of his expenditure on such measures. Each mine or each coalfield has its own advantages and disadvantages, and there is no more reason why the coal industry in general should finance, even partly, sand-stowing in one mine than there is for its paying the extra cost of guarding against floods in another or the extra cost of winning hard coal from thin seams in a third. Any increase in the price of coal from certain collieries that compulsory sand-stowing may lead to must be borne by the colliery concerned as an incident of its business."

380. Our counter-arguments are as follows in addition to, or in support of, those already put forward in paragraph 263 of Chapter X:—

(*a*) The universal cess will leave all producers and consumers in the same relative position as they now are.

(*b*) The imposition of the cess on Chanda coal only would result in such a severe competitive handicap that the mines would have to be closed down as no longer remunerative. The Pench Valley coal would gain such a competitive advantage that it would soon oust Chanda coal from the market.

(*c*) The Central Provinces Government admits that, in certain classes of mines, particularly in the Chanda Field, sand-stowing will probably be necessary. In our opinion there is no probability about the matter at all. We are convinced that the general necessity in the Chanda area of the Wardha Valley Fields will be at least equal to that in the Jharia Field and greater than in the Raniganj Field. With the exception of the coal lost at the Warora Colliery, there has been no serious accident nor loss of coal up to the present sufficient to convince the Local Government of the necessity for sand-stowing, but all the coal hitherto obtained has been from first working, and the mines are only now reaching the stage of development when pillar extraction will have to be commenced. Pillar extraction by ordinary methods in the Chanda area will certainly result in very heavy losses of coal and very considerable danger to those working in the mines. Without sand-stowing the average percentage of recovery will not be more than 50 per cent., and this is not a prospect which the Local Government can view with equanimity. In the Jharia and Raniganj Fields there are many mines which will never benefit by the cess, but there are obvious practical

difficulties in imposing and collecting a cess differentiating between one field and another, or between one mine and another in the same field. Such differentiation would give some producers a gratuitous commercial advantage over others, and would foster opposition to measures which are urgently necessary in the interests both of safety and conservation.

(*d*) The cess proceeds will be used not only for compulsory stowing, but also to control section-working, depillaring and rotation of working, and to assist research and the education of miners (see paragraphs 343 and 356 *ante*).

381. As regards coal from Indian States, there seems to be no valid argument against the cess being levied on that coal when brought into British India for competition with coal produced in British India which will be paying the cess.

382. RAILWAY FREIGHTS.—Some of the Central Provinces witnessses voiced a local grievance against certain railway freights which are said to operate telescopically in favour of long-distance coal traffic from the Bengal and Bihar Fields. We did not examine this grievance in any detail partly because it does not come directly within our terms of reference, and partly because it is, we understand, to be fully gone into shortly by the Railway Rates Advisory Committee.

CHAPTER XV.

Summary of Conclusions and Recommendations.

383. The conclusions and recommendations in our Report may be summarised as follows:—

(1) Advantages and disadvantages of the panel system discussed. With principles of first working laid down by regulation the necessity for the panel system will be considerably reduced. Where it is the intention to extract pillars in conjunction with simultaneous stowing, the panel system is unnecessary. (Paragraphs 35-40.)

(2) The advantages of stowing have been known for many years, but individual action has not been possible generally because of the competitive disadvantage imposed by the additional cost. The only effective action possible is by Government initiative and intervention. (Paragraphs 42-43.)

(3) Though there have been contributory causes such as the general economic depression, the indifference of landlords to their own interests and the inaction of Government in the face of a growing national emergency, it is undeniable that the trade and industry is itself mainly responsible for its unsatisfactory condition. (Paragraph 51.)

(4) The present low prices are due to the interaction of keen competition and decreased demand due to the general depression. (Paragraph 53.)

(5) Production costs of nine companies discussed. (Paragraphs 54-56.)

(6) The managing agency system, though it may have answered the requirements of the coal trade as distributors and profit-producers, has not been an unmixed advantage to the coal industry. (Paragraph 57.)

(7) The difference between the sound mining or safety point of view and the commercial or profit-making point of view explained. (Paragraph 57.)

(8) A new spirit of co-operation and co-ordination among controlling firms is essential if conditions are to be improved and fresh remedies tried. (Paragraph 59.)

(9) A trade union among managers is required to safeguard them against arbitrary dismissal and to ensure reasonable continuity of employment in the same mine. (Paragraph 59.)

(10) The legal liability of owners and agents for methods of working should be made clear. (Paragraph 59.)

(11) Agents should be required to have at least the qualifications of the managers working under them. (Paragraph 59.)

(12) Public attention has been drawn to the coal trade and industry because of the serious mining accidents that have occurred during the last two or three years. (Paragraph 60.)

(13) Some accidents are directly connected with wasteful methods and practices; other have no connection with methods of working. Accidents are bound to happen, but steps should be taken to prevent conditions arising which cause accidents or magnify their consequences. (Paragraph 61.)

(14) Examination of recent fatal accidents. (Paragraph 63.)

(15) " Waste " means underground waste and does not include waste caused during any process of distribution or consumption subsequent to extraction from the mine. (Paragraph 64.)

(16) The average waste of coal is about 50 per cent. of which all but 10 per cent. would be saved by stowing. This 10 per cent. waste must probably always occur in order to keep the mine safe. The 50 per cent. waste is made of 15 per cent. in sections left, 15 per cent. in barriers, 15 per cent. in actual depillaring, and 5 per cent. in fires and collapses. (Paragraph 64.)

(17) Avoidable waste defined as all waste which is not incidental to a proper and efficient working of the system of mining that is being followed. (Paragraph 65.)

(18) National interests require that all kinds of avoidable waste should in future be strictly controlled and prevented as far as possible. (Paragraph 67.)

(19) The seams of the Raniganj series are more liable to spontaneous combustion than those of the Barakar series. Of the Raniganj series, the seams in the eastern section of the Field are, because of their higher moisture content, more liable to fire than the seams of the western part. As regards the Barakar series, seams Nos. 13, 14 and 15 are the most liable to spontaneous combustion, but fires have also occurred in seams Nos. 10, 11 and 12. The seams in the Bokaro and Karanpur Fields are very liable to spontaneous combustion, but those in the Giridih Field are comparatively less liable. (Paragraph 78.)

(20) In the seams of the Barakar series below grade II in quality, which have an extremely low moisture and low volatile and high ash content, the danger of spontaneous combustion is extremely remote. As regards seams in the Raniganj series with their high moisture and high volatile content, they are all liable to spontaneous combustion even when below grade II in quality. (Paragraph 79.)

(21) " Period of incubation " defined as the period between the first heavy fall of roof in a goaf up to the first evidence of heating. The period of incubation varies with the ventilation conditions, the nature and quantity of the coal left, and the depth from the surface. It varies from a few weeks to two years, 9 to 18 months being the general average. (Paragraph 80.)

(22) " Fire area " includes not only an area actually under fire, but also one which has been sealed off on heating being discovered and has never been re-opened since. (Paragraph 81.)

(23) Loss of coal from collapses and fires discussed with statistics up to the end of 1927, and from 1928 to the end of 1936. (Paragraphs 84-92.)

(24) The cause of the Bagdigi explosion discussed with reference to the question of the generation of gases by inundations. The generation of water gas in the manner suggested is largely a hypothesis, and a combination of conditions favourable to the generation of such gas would be extremely rare in actual practice. (Paragraph 96.)

(25) Explosions in mines discussed with reference to fatal casualties and the presence of fire-damp. (Paragraphs 97-104.)

(26) Electric safety lamps, though more expensive, are preferable in Indian mines to flame safety lamps. (Paragraph 105.)

(27) Explosions by an ignition of fire-damp may be accentuated and carried through the whole mine when coal-dust is present. (Paragraph 108.)

(28) Coal-dust explosions have occurred where the igniting medium has quite definitely not been fire-damp. The danger from coal-dust in all mines should therefore be guarded against. (Paragraph 112.)

(29) Conservation should make available safely the maximum quantity of extractable coal of commercial or industrial value. Without further research, a policy of coal conservation should only cover utilisation by those whom Government already controls. (Paragraph 116.)

(30) Reserves of good quality coal in India discussed with figures up to the end of 1936. (Paragraphs 119-124.)

(31) The life of the reserves of all good quality coal is 122 years. The life of the reserves of coking coal of good quality is 62 years. The life of the reserves of all good quality coal in Jharia is 81 years, and of coking coal 57 years. (Paragraphs 125-129.)

(32) The reserves of iron ore, even of good quality only, far exceed the available reserves of coking coal. (Paragraph 130.)

(33) No measures of conservation in the interests of the iron and steel companies alone would be justified. Any legal measure of conservation should apply to all good quality coal and should be introduced as a matter of public policy in the interests of the community as a whole. (Paragraphs 135-136.)

(34) The permanently-settled zemindars in Bengal and Bihar have not controlled their lessees properly even in their own interests, and have in consequence not only lost royalties on large quantities of coal, but have also caused the country's coal resources to be correspondingly depleted. (Paragraph 139.)

(35) The proposed Statutory Authority should be given power to supervise and control the terms of new leases so far as technical matters are concerned. Subsequent *salami* for allowing extraction of pillars should be prohibited. The control should extend to securing leaseholds of adequate sizes and more or less rectangular boundaries, and also periods of leases sufficient to facilitate the use of sound mining methods. (Paragraph 139.)

(36) The average percentage of output now being obtained from pillars is over 60. This percentage will go on increasing as the virgin areas and seams awaiting development diminish until, as the resources approach exhaustion, the whole output will have to be recovered from pillars. (Paragraph 140.)

(37) The percentage of coal likely to be recovered from standing pillars will not be more than 60 per cent. in the Raniganj Field, while it is extremely doubtful whether it will reach 50 per cent. in the Jharia Field. These percentages take into account wastage both from present methods of working and from collapses and fires. (Paragraph 143.)

(38) When depillaring is done, stowing will be at least as necessary in the Bokaro and Karanpur Fields as it is now in Raniganj and Jharia. (Paragraph 144.)

(39) The only object of the Government of India and the Indian Coal Committee of 1925 was to improve the quality of export coal and to regain foreign markets. The Committee's suggestion was that a Grading Board should be established to grade collieries which produced coal for export. The Act as passed allowed the grading of coal of all or any of the seams or of a part of a seam, and this provision has enabled grading to be extended to coal not intended for export with the result that almost all coal produced in the Bengal and Bihar Fields is now offered and bought under the Grading Board classifications. (Paragraph 148.)

(40) The foreign export trade, though insignificant as compared with the internal trade, is diminishing steadily. Besides authoritative and reliable grading, the export trade is assisted by other concessions not enjoyed by the internal trade. (Paragraphs 149-151.)

(41) Section-working as a method of commercial exploitation has grown considerably since the Coal Grading Board Act of 1925 was passed, partly owing to the facilities provided for grading on which consumers think they can rely, and partly owing to low prices and generally unfavourable market conditions. (Paragraph 154.)

(42) The grading system has introduced a standard classification of Indian coals by uniform methods of sampling and analysis, and this classification has enabled consumers to have a definite basis for their orders as long as the colliery remains on the grading list. Stability both during first working and depillaring has also been improved because galleries have not been so high as when the whole seam was worked at once. Yet avoidable waste of coal of commercial value has increased appreciably, while the danger of

fire following local and main falls of roof has also been increased. (Paragraph 155.)

(43) The only satisfactory solution is to stop the grading of sections of seams and cancel the existing certificates of such grading. If any colliery, which has had its grading certificate cancelled, applies for a fresh certificate for the whole seam, it should be allowed to have this without any charge. All that is necessary to give effect to this recommendation is to amend Section 4 of the Coal Grading Act by omitting the words " or of a part of a seam ". (Paragraph 157.)

(44) The effect of our recommendation on the export trade. (Paragraph 158.)

(45) Export of non-graded coal should be prohibited. (Paragraph 159.)

(46) The effect of our recommendation on the internal trade. (Paragraph 160.)

(47) The surplus funds and future net actual income of the Coal Grading Board should be handed over to the Statutory Authority and added to the proceeds of the general cess for the benefit of the coal industry and trade as a whole. (Paragraph 161.)

(48) The amount of coal which is locked up under railways, and which, without adequate stowing, will have to be sacrificed for support, runs into hundreds of millions of tons. The compensation payable on such coal left for support, calculated in terms of working profits, would amount to much more than the railway administration can contemplate with equanimity, while its compulsory payment must recoil mainly on the coal trade as a whole. (Paragraph 162.)

(49) The general problem of coal locked up under railways is complicated. Apart from considerations of conservation and extraction of all coal within mining possibilities, the ideal arrangement would be one in which all the parties concerned were directly interested in economising support as much as possible. The Land Acquisition (Mines) Act of 1885 confers a statutory right to compensation for coal required for vertical support. This right has been nominally relinquished by mine-owners under stress of circumstances, and it remains to be seen how far the Assisted Siding Agreements have deprived mine-owners and others of their statutory rights. There has been no authoritative legal decision regarding the effect of the Assisted Siding Agreements in extinguishing or limiting the statutory right to compensation granted by the 1885 Act. (Paragraphs 163-168.)

(50) Whatever the legal position may be, the only satisfying remedy is to stow the void created by removing coal from under the railway lines with some incombustible material which gives as secure support as the coal itself. (Paragraph 169.)

(51) The railways should contribute towards the cost of compulsory stowing by collecting the general cess without charging any commission. (Paragraph 171.)

(52) The Government of Bengal has locked up large quantities of coal under the Grand Trunk Road. The Local Government's attitude is opposed to any general policy of conservation of good quality coal. The Local Government should therefore lease this coal and permit it to be recovered, even without stowing, so far as the Chief Inspector of Mines thinks will not prejudice the safety of the Road. With stowing directed by the proposed Statutory Authority, all this coal should be recovered except what has already been lost for ever. (Paragraph 173.)

(53) Section 84 of the Bengal Tenancy Act should be amended so as to allow the same procedure as obtains under the Chota Nagpur Tenancy Act for the acquisition of a holding or any part thereof for the purpose of mining. (Paragraph 175.)

(54) Wasteful methods are found both during prosperity and during depression. (Paragraph 178.)

(55) There has been a world-wide economic trend away from the competitive ideal towards formulas of public control. In all parts of the world, public control over production, distribution and consumption has been tightening. (Paragraph 180.)

(56) The case for rationalisation is particularly strong so far as coal mining is concerned. (Paragraph 182.)

(57) The steps taken in this direction in Great Britain, Germany, the United States of America, France and certain other countries. (Paragraphs 183 to 191.)

(58) Objections have always been made against any innovations considered likely to affect profits. This old, but now obsolescent, attitude has been waived aside in Great Britain and will almost certainly meet with the same fate in this country. State control of coal output and prices must come eventually in India unless there is a radical change in the psychology of the coal trade. There is considerable scope for rationalising not only the various elements of the coal trade and industry, but also the activities of landlords, mine-owners, railways and the iron and steel and other industries. All this should be an essential function of the proposed Statutory Authority after it has dealt with the more urgent problems of safety and conservation. (Paragraphs 192-193.)

(59) The case for State control in order to prevent avoidable waste and secure conservation of available reserves is very much stronger now because the proportion of coal won from pillars is so much greater, because the waste, damage and danger during pillar extraction are all very much larger than during first working, because the alarmingly limited extent of Indian reserves of coal of good quality has been established scientifically, and because the coal trade and industry is now in a parlous plight from which there seems to be no hope of extrication by its own efforts. It has become the duty of Government as representing the existing community, and as trustees of posterity, to step in and impose some definite line of action upon the coal trade and industry. (Paragraph 194.)

(60) The original intention was to hand over the work of the Coal Grading Board to the coal trade within a comparative short time after the Act came into force in 1925. Eleven years have since passed, and the Chief Mining Engineer's Department is still in charge because it is admitted that the coal trade cannot do the work as cheaply nor with the same efficiency and disinterestedness. (Paragraph 195.)

(61) As regards the State Collieries, all that can reasonably be expected has been done by the State Railways agreeing to purchase two-thirds of their coal requirements from the collieries of limited companies and private owners. Similar limits might be applied to the purchases of Company-managed railways obtaining their coal requirements through the Chief Mining Engineer to the Railway Board. (Paragraph 196.)

(62) In the circumstances described above, State initiative and State intervention constitute the only remedy and are already overdue. (Paragraph 198.)

(63) The amount of State control necessary in any particular country must depend on the nature and urgency of the situation, and the situation in India demands as much control as is possible without nationalising the mines or the royalty rights. (Paragraph 199.)

(64) Until the temporary legislation of 1936, the law restricted State control to safety of life without any provision for safety of property. Even as regards safety of life, the powers of the Mines Department were more protective than preventive. (Paragraph 200.)

(65) The amending Act of 1936 was followed by several Temporary and Supplementary Regulations. It empowered interference for the first time with conditions likely to cause danger, or likely to result in or aggravate accidents, and provided a speedy remedy for conditions of apprehended danger or such are likely to cause danger. All this marked a great advance, but the legislation and regulations will only remain in force for two years unless permanently enacted meanwhile. (Paragraph 201.)

(66) Practically every witness agrees that the temporary legislation and regulations should be made permanent. (Paragraph 202.)

(67) General principles of first or whole working should be laid down by regulation with certain safeguards. (Paragraphs 203-208.)

(68) In the case of seams which it is intended to work in more than one section, the best plan will be to prescribe by regulation that the lay-out of projected workings of all seams which are being so worked, or are about to be so worked, should be submitted to the Statutory Authority for approval before any coal-getting is done. (Paragraph 209.)

(69) The above principles of first working and section-working will continue in force until systematic depillaring operations begin.

It should be laid down by regulation that no departure from these principles will be allowed more than two pillars' length ahead of the pillar that is being extracted or from the point at which pillar extraction is about to begin. (Paragraph 210.)

(70) Control over depillaring operations will also be essential and should be exercised by Statutory Authority by examining and approving plans of proposed depillaring operations. (Paragraphs 211-212.)

(71) The Statutory Authority should also control rotation of working. (Paragraph 213.)

(72) Control over accumulations of gas in goaves is also necessary. Each case will have to be judged on its own merits. The Chief Inspector of Mines will be the authority to prohibit the extraction of pillars in gassy seams except in conjunction with stowing. When he passes such an order, the mine-owner concerned will apply to the Statutory Authority for financial assistance in connection with the compulsory stowing. (Paragraphs 214-218.)

(73) The use of electric safety lamps would reduce the danger of accumulations of gas, but would not be a sufficient remedy by itself. Electric safety lamps are the next best protective to stowing, but gas expelled may also be ignited in other ways. The best plan is to eliminate the chance of gas accumulating in goaves and this can only be done by compulsory stowing with financial assistance. (Paragraph 219.)

(74) The advantages of stowing and various kinds of stowing are described. As sufficient supplies of water and sand are usually available, hydraulic sand-stowing is the most suitable method in the coalfields of India especially as the gradients of the seams are for the most part favourable. (Paragraphs 220-221.)

(75) The available figures indicate that the supplies of sand in the Damodar, Barakar and Adjai Rivers are more than sufficient for all requirements even for wholesale sand-stowing. Any sand removed for sand-stowing from the fixed deposits would be replaced every year by the current accounts during the monsoon floods. (Paragraphs 222-226.)

(76) Other stowing materials, such as broken stone, alluvium, etc., are also available in large quantities. (Paragraph 227.)

(77) The difficulties of the transport and distribution of sand to stow collieries are not insurmountable. The only two means of transport capable of dealing with large quantities of sand are railways and aerial ropeways. (Paragraph 228.)

(78) The suitability of railways for the proposed transport of sand discussed. (Paragraphs 229-230.)

(79) The suitability of aerial ropeways discussed. (Paragraphs 231-233.)

(80) Conjectural estimates of expenditure on ropeways are given, but it is difficult even to arrive at even an approximate figure without a full and detailed survey of the whole problem. (Paragraphs 234-236.)

(81) Transport by aerial ropeway is the most generally applicable method for collieries lying at a distance from the rivers. A dual system of railways and ropeways may be of use in some instances. (Paragraph 247.)

(82) The most satisfactory arrangement for the supply and distribution of sand would be by a public supply company in which Government should hold at least 51 per cent. of the shares. (Paragraph 248.)

(83) The effect of compulsory stowing in the Raniganj and Jharia Fields would be that the life and productivity of the collieries would be almost doubled. This estimate contemplates that compulsory stowing will be universal in thick seams, but this will not be practicable at first. In the beginning, the determining criterion will be the urgency of the danger or the urgency for conservation against immediate loss of coal. (Paragraph 249.)

(84) Compulsory stowing will have to begin first in certain areas, conditions and seams. (Paragraph 250.)

(85) All collieries which are already stowing voluntarily should be encouraged to continue and be assisted. Collieries wishing to start stowing voluntarily after the general cess is imposed shall submit their plans and estimates to the Statutory Authority, and the latter should decide in each case the most equitable terms on which stowing should be assisted. (Paragraph 251.)

(86) The average cost of extracting and loading sand by manual labour, and of haulage to the loading bunker of a distributing ropeway, would be 1 to $1\frac{1}{2}$ annas per ton. The average cost of transporting sand by aerial ropeways would be between ·75 and 1 anna per ton-mile. Assuming that the average distance for which sand will have to be transported is 6 miles in both Fields, the cost would be $5\frac{1}{2}$ annas to $7\frac{1}{2}$ annas per ton of sand delivered at the colliery. These figures do not include any provision for royalty or other charge on the sand itself. (Paragraph 253.)

(87) The average cost of underground stowing is estimated at from 4 annas to 7 annas per ton of sand, but this is necessarily only a very approximate estimate. (Paragraph 255.)

(88) Assuming that on the average 50 per cent. of coal has been extracted in first working, 2·7 tons of sand would be required to replace every ton of coal recovered. The average cost of stowing per ton of coal recovered from pillars will vary from Rs. 1-9 to Rs. 2-7 for complete stowing and for transport of sand from a distance of 6 miles. The cost will be considerably less when it can be distributed over the whole output of a colliery. The average cost of total replacement per ton of coal raised from virgin areas will be from 12·8 annas to Rs. 1-3-6 again with an average distance of 6 miles. (Paragraph 256.)

(89) The above figures of the cost of stowing would be reduced by savings on certain items. (Paragraph 257.)

(90) It should be considered what steps should be taken in the national interest to prevent the owners of sand rights from profiteering or selling at such an inflated price as will interfere financially with stowing operations. (Paragraphs 258-259.)

(91) Compulsory stowing for purposes of safety and conservation should be financed by a general cess on all coal (including soft coke) and hard coke (unless the coal from which it has been made has paid the cess already) despatched by rail in and into British India. The cess would be collected by the railways as a surcharge on railway freight from the party paying that freight, and would be credited to the Statutory Authority under the same procedure as is now followed under the Indian Soft Coke Cess Act VIII of 1929. (Paragraph 260.)

(92) The above cess should be at the same rate on all qualities of coal and should be applied universally to all coalfields. (Paragraphs 261-263.)

(93) The cess should be accompanied by an equivalent countervailing import duty on foreign coal and coke, and an equal drawback on coal and coke exported to foreign countries. (Paragraph 264.)

(94) The cess rates should be 8 annas a ton on coal (including soft coke) and 12 annas a ton on hard coke (assuming that 1½ tons of coal is necessary to manufacture 1 ton of hard coke). These rates should remain in force for the first three years and should be reconsidered at the end of that period. (Paragraph 265.)

(95) The impact of the cess will fall on the consumer, but its incidence will be determined by market conditions of demand and supply. Further, though pit-head value may be raised by the amount of the cess, the proportional increase in the price paid by most consumers will be much less. (Paragraph 266.)

(96) Landlords should contribute directly to the cess by paying 10 per cent. of the royalties actually received by them each year. Where no royalties are being paid because royalty rights have been acquired by the mine-owner, or where only a dead rent is being paid, it should be assumed that royalty rights are worth 4 annas a ton on coal despatched less dead rent, if any, and 10 per cent. should be paid on the net amount. (Paragraph 268.)

(97) The contribution of Government should take the form of paying for the extra staff of the Mines Department, for part of the permanent staff of the Statutory Authority, and for research to the extent proposed later. In addition, plant and machinery for stowing purposes imported by, or under a certificate from, the Statutory Authority should be allowed into the country free of import duty. (Paragraph 269.)

(98) Assistance for underground stowing should be limited to a supply of free sand at the colliery for the first three years when the eight and twelve annas cess rates are in force. (Paragraph 270.)

(100) The Statutory Authority should be able to make advances, when satisfied that such advances are necessary, for the purchase of pipes and plant by collieries where stowing has been ordered. (Paragraph 272.)

(101) Functions of the proposed Statutory Authority dealt with. (Paragraph 273.)

(102) It will be better not to attempt even a transient definition of coal of commercial or industrial value. The Statutory Authority should decide each case with reference to the particular circumstances including safety, and with reference also to the time at which the decision has to be taken. (Paragraph 274.)

(103) The Mines Department should be represented on the Statutory Authority and should be the executive agency of that Authority so far as to underground operations are concerned. (Paragraph 275.)

(104) The orders of the Statutory Authority should be final as regards all its functions. (Paragraph 276.)

(105) The Statutory Authority should be an expert and not a representative body. It should have an independent Chairman, with the Chief Inspector of Mines, one commercial expert and three mining experts as members. (Paragraphs 278-279.)

(106) The independent Chairman should be a senior Government official. (Paragraph 280.)

(107) The Chief Inspector of Mines should be a member of the Statutory Authority because safety and conservation are very nearly allied, and it will usually be difficult in practice to determine whether compulsory stowing is necessary in the interests of safety or of conservation. (Paragraphs 282-283.)

(109) The Chairman should be a whole-time officer paid by the Government of India. The other members, except the Chief Inspector of Mines, should be paid fixed fees *plus* first class travelling allowances for attending meetings, their fees and allowances being paid out of the cess funds. A Secretary with accounts experience and some knowledge of finance, and a qualified Ropeways Engineer, should be appointed and paid by the Government of India. The subordinate staff appointed by Chairman should be paid out of the cess funds. (Paragraphs 284-285.)

(110) The staff of the Mines Department should be increased. The salary of the Chief Inspector of Mines should be raised to a maximum of Rs. 3,000. (Paragraphs 286-289.)

(111) Changes in the Act and Regulations considered necessary. (Paragraphs 290-328.)

(112) As there are financial and other difficulties in nationalising mines, or nationalising royalty-rights, or nationalising undeveloped properties, control on the lines suggested earlier in the Report is the wisest policy for India at present more particularly in the existing stage of her political evolution. (Paragraph 329.)

(113) The possibility of a Central Marketing Agency should be investigated. (Paragraph 330.)

(114) The Statutory Authority should be empowered to arrange voluntary amalgamations if possible and then proceed to compulsory amalgamation if the owners will not come to terms. (Paragraphs 331-332.)

(115) The Statutory Authority should be empowered to adjust irregular boundaries on equitable terms, and transfer areas which cannot be worked from the parent property to an adjoining property from which they can be worked. (Paragraphs 333-335.)

(116) The Statutory Authority should be empowered to take over abandoned properties on fair terms and either work them or arrange for them to be worked by some other owner on suitable terms. (Paragraphs 336-337.)

(117) If a policy of conservation of good quality coal is definitely adopted, Government must be consistent in its application by assisting conservation as regards the utilisation of coal by agencies under its control. The G. I. P. Railway is already using for its locomotives Central Provinces coal of inferior quality, and other railways near the Bengal and Bihar Fields might be required to adopt the same policy. (Paragraphs 338-339.)

(118) A Coal Research Board should be set up and financed partly by Government contributions and partly out of the cess funds at the disposal of the Statutory Authority. The Coal Research Board should be under the Statutory Authority. (Paragraphs 342-343.)

(119) It should be considered whether any preference, similar to the one allowed in Great Britain, should be given in India to encourage the manufacture of benzol as a motor spirit from coal. (Paragraph 344.)

(120) Appeals under section 19 (5) of the Indian Mines Act should be heard by Appellate Tribunals consisting of a Chairman nominated by Government, a representative of the Mines Department nominated by the Chief Inspector of Mines, and three mining engineers nominated by the Government of India, one of whom will be suggested by the appellant. (Paragraph 345.)

(121) The introduction of the group system of railway freights in the Raniganj Field should be reconsidered. (Paragraph 346.)

(122) The scheme for two Central Rescue Stations in the Jharia and Raniganj Fields should be adopted. (Paragraph 347.)

(123) The keeping of gas masks or self-rescue apparatus in mines should not be required by regulation, but such apparatus may be very useful in certain circumstances. (Paragraph 348.)

(124) Certain provisions should be added to the existing rules regarding ambulance and first aid work. (Paragraph 349.)

(125) The application of the Payment of Wages Act to coal mines should be further considered before action is taken. (Paragraph 351.)

(126) The Statutory Authority might function as a mining education board and obtain the necessary funds partly from Government, partly from local authorities, and partly from the cess funds. (Paragraphs 352-356.)

(127) Pillars in the coal mines of the Chanda district could not be extracted without stowing. Compulsory stowing should therefore be introduced in these mines. (Paragraph 371.)

(128) Compulsory stowing for ordinary purposes is not necessary in the Pench Valley area, but will be necessary to recover coal under railway lines, buildings and other surface features for which support has now to be left. (Paragraph 372.)

(129) Control over mining methods is as necessary in the Central Provinces as elsewhere. (Paragraph 373.)

(130) The measures of control suggested as regards first working, section-working, depillaring, etc., for the Raniganj and Jharia Fields should also be introduced in the coalfields of the Central Provinces. (Paragraphs 374-378.)

(131) The Central Provinces should arrange with the Government of India for the inspection of its mines with reference to the terms in its leases regarding methods of working. (Paragraph 378.)

(132) The general cess should apply to all the fields in the Central Provinces. (Paragraphs 379-380.)

The signatories of this Report other than Mr. Nag and Dr. Krishnan desire to add the following observations with reference to the so-called "Supplementary Note" attached to the Report. Mr. Nag and Dr. Krishnan begin by saying that they agree with all our recommendations regarding safety and conservation, and think that they should be given effect to immediately, but they add that the proposals regarding conservation do not go far enough. They then go on to suggest their remedy of nationalisation of royalties followed by nationalisation of mines, but they support these recommendations by detailed criticisms of some of our more important and fundamental proposals with the idea apparently of establishing that these proposals (with which they have in the beginning expressed concurrence and suggested immediate action on) are so unsound and unworkable that they will not produce the desired results. These two gentlemen are of course entitled to their own opinions, however paradoxical these may appear, but we feel bound to say that it is most regrettable that we were not informed of their intention to make these criticisms until we had practically finished our discussions on the draft Report. It is true that some of the criticisms were referred to and raised in argument now and again while the witnesses were being examined and the terms of our Report discussed, but not one of them was expressed when our conclusions on every point were arrived at and were recorded

as a basis for the Chairman to draft the Report on. Dr. Krishnan has explained this by saying that, as one debated point, which is not again raised directly in the Note, was decided against Mr. Nag's opinion by a majority vote, they did not think it worthwhile making any further criticisms or objections until they could do so in this " Supplementary Note ". We regret very much that some of our recommendations should have been attacked by criticisms from two of our own members, but we are still confident that all our recommendations are sound, and that they go as far as can reasonably be expected at present. The whole problem is admittedly a difficult one and we have done our best to suggest practical solutions. We should not be surprised if far more people say that our proposals go too far rather than that they do not go far enough. With these remarks, we must now leave our work to be judged and acted on by others, only adding that it will be disastrous if no action is taken, and that any action that is taken should be taken as expeditiously as possible.

(Signed)

L. B. BURROWS
(*Chairman*).

J. C. COYAJEE.

J. MACKIE.

H. K. NAG.

N. BARRACLOUGH.

M. S. KRISHNAN.

(Signed)

M. IKRAMULLAH,
Secretary,

10th April, 1937.

SUPPLEMENTARY NOTE.

1. The Committee's terms of reference contain two main subjects for inquiry—safety and conservation. Recommendations have been made with regard to both, and we are in accord with our colleagues on all measures which they recommend with regard to safety. But those suggested for ensuring conservation, although urgent and should be given immediate effect to, for arresting the aggravation of conditions and for preventing waste, are, in our opinion, inadequate and will be found in practice to fall short of what is necessary to achieve the object in view. We shall, therefore, discuss the relevant points only in that connection and outline a course of action which, we hope, will comprehensively deal with the situation.

2. From the evidence tendered before the Committee it will be seen that some of the important witnesses expressed the opinion that there should be no control as regards conservation, but that if the Government were to enforce any such control, the owners of the mines (*i.e.*, lessees actually working the mines) should be compensated and the properties acquired by the Government. They looked upon control over production and safety of the mineral property as an unwarranted interference with the rights of private property and enterprise. But in view of our limited reserves and the rapid depletion thereof, as will be shown presently, the necessity for conservation is imperative and action should be taken immediately.

3. RESERVES OF COAL.—Before considering the question of conservation, let us look at some relevant figures. In comparison with the reserves [1] of U. S. A. (2,889,000 million tons), Germany (288,720 million tons), Great Britain (176,000 million tons) and China (250,000 million tons), India's reserves of workable coal of all grades to a depth of 1,000 ft. are estimated to be around 20,000 million tons [2]. This estimate includes all coal in seams of 4 ft. thickness and over, and having an ash content of up to 20 per cent. The reserves of good quality coal, with an ash percentage not exceeding 16 on a moisture-free basis and to a depth of 2,000 ft., were estimated at 5,000 million tons at the end of 1932. Allowing for extraction since, the present reserves of good quality coal may be put at 4,889 million tons, while those of good coking coal amount to 1,426 million tons [3], nearly 60 per cent. of which are in the Jharia coalfield which contains the best coking coal in India outside Giridih.

4. LIFE OF THE RESERVES.—Because of the thickness of the seams and their proximity to one another, the methods of extraction in vogue allow of only 50 per cent. recovery, the balance representing

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(1) These figures were taken from the papers presented before the Third World Power Conference, Washington, D. C. (1936).

(2) C. S. Fox—*Memoirs, Geol. Surv. Ind.*, LIX, p. 344 (1934).

(3) *See* Chapter VI, pp. 70-71 of the main Report.

losses in sectional working, in boundary and panel barriers, pillar extraction, collapses and fires. At present the average annual production of good quality coal is around 20 million tons and of good coking coal is roughly 11·5 million tons. Calculated on the above basis, and including 50 per cent. loss in recovery, all our good quality coal will last for about 122 years while good coking coal will last only for 62 years. In practice the above-mentioned periods are likely to be even shorter as, with the industrial development, the consumption of all coals is bound to increase.

5. COMMITTEE'S RECOMMENDATIONS.—Our Committee has made a number of recommendations both for the safety of the mines and for conserving the coal assets of the country. We wish to make it clear that we agree to all the " Safety " recommendations of the Committee, but at the same time we wish to point out that the measures proposed for promoting conservation cannot solve the problem.

6. CONSERVATION.—This has two important aspects. The first, which most people think of ordinarily, relates to the reduction and avoidance of waste in the winning of coal. At present, such waste is very large, particularly in the sectional working of thick seams where most of the coal of inferior quality is usually left behind. This lose apart, the coal thus left behind leads to spontaneous fires and endangers the property.

7. The other aspect of conservation, which in our opinion is equally important, appertains to the proper uses to which different types of coal can be put and also to economy in actual use. This aspect of the question will be examined by us in greater detail later on. We shall now proceed to discuss some of the important recommendations of the Committee , and point out their inadequacy.

8. SECTIONAL WORKING AND GRADING.—The Committee has examined the problem of sectional working at length and is of the opinion that it is to a very large extent responsible for the waste that is occurring in our mines. This is certainly true, but sectional working merely represents the manner in which the inherent difficulties of working thick seams in India, have to be tackled. Sectional working has always been practised in thick seams and will continue, whatever the future conditions of mining are. As a matter of fact, it will be further encouraged by the restrictions imposed on the height of galleries to 10 ft., as recommended by the Committee. The only difference between the present practice and that which may be enforced by the Statutory Authority will be that, in order to avoid waste, the sections will have to be taken up systematically from the bottom upwards and each section stowed before the higher one is depillared. This, however, will bring difficulties in its train, for the whole question of mining by private capital centres upon whether the particular quality of coal worked has a market and whether it can be sold at a profit. The best sections, whether they are at the bottom, middle or top, are always

worked first and the remainder is often left behind and lost unless it can be worked at a profit.

9. Closely connected with the sectional working is the question of the effect of the working of the Coal Grading Act (1926). Our Committee is under the impression that sectional working with the consequential avoidable waste has been considerably intensified by the system of grading which is in vogue. This view we do not fully share nor do we think that the proposed cancellation of the grading certificates would be a remedy as, in any case, the sectional working of better quality coal irrespective of the position in the seam will continue, unless the State undertakes to provide the market for the inferior coal that might be raised.

10. The Committee has recommended that Government should use such coal for the Railways and other agencies under their direct control. We do not see any reason why this should be forced on the State agencies while the other consumers are left alone to exercise their free choice. The State agencies, as economic units, will object to this procedure and can reasonably ask that all other consumers should also participate in the use of such coal.

11. Moreover, there is nothing to prevent owners from working the sections already graded, unhindered for a number of years, despite the cancellation of the grading certificates, unless the State were to prohibit such working.

12. Under the scheme of control and compulsory sand-stowing contemplated, the working of all coal, considered to be of commercial value by the Authority, will be enforced. It is of course undesirable either from the point of view of safety (because coal left in the goaf is the main cause of fire during the depillaring stage, unless stowed) or from the conservation point of view (for coal up to 30 per cent. ash or even higher, is a valuable national asset and should not be wasted), to lose any coal which it does not pay a mine-owner to recover for the time being.

13. But supposing the owners have to work such coal under the orders of the Controlling Authority, would they not be entitled to compensation if there is no market for it? The remedy is to control *output and distribution* strictly for without such control it will be impossible to regulate the supply according to the market requirements. It will also be necessary to educate the consumers as to the qualities of coal which they can advantageously use in substitution of the coals to which they are accustomed.

14. Compulsory stowing.—It has been estimated by the Chief Inspector of Mines that in Jharia (1) there are 163 million tons and in Raniganj 133 million tons of good quality coal standing in

(1) Mr. R. R. Simpson, the late Chief Inspector of Mines, stated in 1929, in his paper on "*The future of the Jharia Coalfield*":—"It is estimated that at the present time there are not less than 120 million tons of first class coal standing in pillars which it is impossible to extract by the ordinary method of mining" (*Trans. Min. Geol. Inst. Ind.*, XXIV, p. 111).

pillars (see page 80). Assuming that 60 per cent. of this could not be properly recovered by ordinary methods and will, therefore, necessitate stowing, the amount of sand required will be (assuming partial stowing and stabilisation, on the basis of only 1·5 tons of sand to 1 ton of pillar coal) at least 270 million tons. Even if a supply of 6 million tons of sand for Jharia and 4 million tons for Raniganj per annum can be arranged within 2 years or so (which will be difficult) it will take about 30 years before the pillars now standing could all be properly recovered and the areas stowed. During this period, with the restricted size of new workings because of the limitation of height of galleries to 10 ft., it will be impossible to maintain the present output from the existing collieries. But if this is to be maintained, extensive machine mining will have to be resorted to and more pillars will be rapidly formed. It must be emphasized that the formation of new pillars in virgin areas will be more rapid than the recovery of pillars by stowing. The new pillars will no doubt be strong and stable but there is a limit to the quantity which can be won from virgin areas because of the limitations as to size of properties and workings in different seams lying one over the other, etc. It is very likely, therefore, that the problems of pillar extraction, which the Statutory Authority will be confronted with, will become more and more acute as time goes on.

15. Under the system of stowing envisaged by the Committee, it may happen that some collieries which are compelled to stow, may find it uneconomic to do so, and may therefore shut down. If this happens, the Controlling Authority will have to assume charge and spend money on stabilising and maintaining the abandoned mines; otherwise they may be a source of danger to the neighbouring properties. It is likely that in several cases no operator will come forward to take over and work the mines in such circumstances; and it is doubtful whether the price received for these mines will be adequate even to cover the expenditure of stabilisation.

16. Before the Controlling Authority get on to the depillaring sections of the mines, there are large areas, especially in Jharia, which are either on weak pillars or on fire and must, therefore, be immediately tackled in order to protect the adjacent seams and neighbouring areas. This will be unremunerative work but absolutely essential as a protective measure and as preliminary to conservation. To isolate properly these fire areas which constitute at present a " no man's land ", and to put out the fires effectively, will require sustained effort and a very large sum of money.

17. It will be pertinent to draw attention to the fact that coal lost by fires and collapses between 1928 and 1936 is 7·8 million tons in Raniganj and 14·0 million tons in Jharia (see page 53). Large amounts of money have already been spent by the Railway Companies and by mine-owners to combat these fires but the protection thus afforded is more or less local.

18. UNIVERSAL CESS.—The question whether the cess to be imposed is to be universal or not is a most difficult one. We must frankly admit that there is much to be said in favour of a general cess as has been pointed out in the Report which we have signed. We do realise that if the cess is not general, certain fields will be placed in a more advantageous position than others, but at the same time we cannot help feeling that the cess is primarily for stabilising large areas in Jharia and Raniganj in the first instance, and also for eliminating the waste in the working of thick seams. It will be many years probably before any other field is tackled.

19. There is no justification in asking everyone to pay for the misfortune of some particular collieries. Of the 23 million tons raised in India annually, Bengal and Bihar account for over 20 million tons. If discrimination cannot be made between one seam and another in the same field, there may be some logic in treating these on the same basis, *i.e.*, within the limits of the same field. But the argument cannot be stretched with justice to the case of a field which cannot now, and can never in future, have any chance of benefiting out of the funds of the cess.

20. The argument has been advanced that, as stowing operations will have the effect of increasing the price and demand for coal in all fields, including inferior coal, all coal should pay the cess, but this argument seems to be unsound. Improvement of price and demand is purely dependent on general economic factors and will happen whatever the cause of the rise of prices of good quality coal may be. It has been argued that the imposition of the same cess on all coal, wherever produced in India and of whatever quality, will leave them in the same relative position. In fact, an equal cess on superior and inferior coal will simply put a greater burden on the latter than on the former. For instance, a consumer who replaces a ton of superior coal by 1·5 tons of inferior coal for achieving his purpose, will really pay 1·5 times as much cess on the latter in comparison with the former, and so this argument breaks down. Hence, there can be no justification for imposing the cess on all fields and, particularly, in the case of those containing inferior coal alone.

21. The present enquiry is confined to Bengal, Bihar and the Central Provinces. Over 80 per cent. of the witnesses examined represented only the former two provinces and predominantly the Raniganj and the Jharia Fields. They would naturally like to be helped out of their difficulties by others and therefore very heartily endorsed the idea of imposing a cess on all coal produced in India. Why should the other provinces, who were not included in the enquiry and whose opinions were not even sought, consent to this procedure? Then again, what will be the position of the coal produced in Indian States? They will naturally oppose the imposition of any cess on their coal sent into British India. The cess, therefore, could be logically imposed only on those fields where stowing operations are likely to be introduced now or in the very near future. If it is found that

the expenditure involved in the introduction of stowing and conservation measures in general are too much for the coal industry of a particular field to bear, then the only remedy will seem to lie in the acquisition of that field by the State. If conservation is to be effective, the measures designed to promote it must be carried out irrespective of the personal predilections or capacities of the owners, and the State, representing the community at large, should take charge and carry out the measures in an organised way.

22. ASSISTANCE FOR STOWING.—A large number of witnesses wanted assistance, over and above free sand delivered at the colliery, varying from a flat rate (calculated on the amount of sand put in or coal recovered) to full cost of stowing. But, after considerable discussion, we all came to the conclusion that the best and simplest form assistance for the enforcement of compulsory stowing will be to supply sand free.

23. There are bound to be cases where some genuine hardship will be experienced in meeting the expense of actual stowing. Under compulsory stowing, some of these mines may find it impossible to carry on and may have to shut down. At the same time, there may be other mine-owners who, with less justification, declare that without assistance they will be compelled to go out of business. To distinguish between these two types of cases will be impossible in practice and both will have to be treated alike, *i.e.*, supplied with free sand only, and no further assistance. This may particularly hit the mines who have practically finished their first working and whose reserves consist mainly of pillar coal, for they will have no cheap coal from virgin areas to balance up cost, and the result may be that some properties will be abandoned. Under such circumstances other operators may not come forward to work the abandoned properties and it will be left to the Statutory Authority to take them over.

24. It has already been pointed out that immediate attention should be paid to fire areas and to those containing weak pillars. Hence, for some years to come, only a part of the sand supply, particularly in the Jharia coalfield where the need is great, will be available for ordinary depillaring operations in thick seams. It is inevitable that discrimination, in respect of sand supply, will occur. The collieries unable to obtain supplies of sand will have to be allowed to depillar in the ordinary way as they cannot be compelled to wait for a term of years for obtaining sand, but ordinary depillaring will be attended by considerable avoidable waste of coal and the dangers which accompany it. Those who are permitted to depillar without stowing will, however, be in a better competitive position as compared to those who win their coal by stowing. In such cases statutory control becomes largely ineffective.

25. CONSERVATION IN USE.—So far, in the preceding paragraphs, we have examined some of the important recommendations made by the Committee in respect of avoidance of waste. Now we go on to the subject of conservation in use.

26. Nowadays, apart from its use as fuel, coal forms an important raw material for several chemical industries. Even as a fuel it still holds the dominant position, in spite of the rapid development of the use of oil and water power, which are its serious competitors. It has already been pointed out that some of the important witnesses were opposed to any control in regard to conservation. Very few had given any serious thought to the aspect of conservation which relates to the use of coal in accordance with its character and suitability. But this is an aspect which must receive immediate attention from all concerned, in view of the limited reserves of superior quality coal, and particularly of coking coal.

27. Coking coal.—Coking coal of metallurgical quality is very restricted in distribution, *viz.*, in Jharia, Giridih, Bokaro and a part of Raniganj. There are some reserves in Assam, but these are of little use for this purpose because of the high sulphur content. The Bokaro coals are in general high in ash while Raniganj coals yield a comparatively weak coke.

28. The production of coking coal from Bengal and Bihar amounts annually to about 13 million tons, of which only about 2·5 million tons are used for the manufacture of metallurgical coke. Restriction of output to the present requirement of 2·5 million tons against the production of 13 million tons will result in increasing the life of the coking coal reserves several-fold. But it will mean that a large number of collieries producing this type of coal will have to close down.

29. In the opinion of a large number of people, such a course will be unjustifiable without compensating the present producers. Further, there is the view that this will be tantamount to restricting conservation to coking coal alone, and that for the special benefit of the metallurgical industries in general and the iron and steel industry in particular. This is a narrow view since conservation in utilisation should apply not only to coking coal but also to other coals of good quality such as are particularly suited for the chemical industry, carbonisation, gas manufacture, hydrogenation, etc.

30. Dealing with the question of coking coal, it is true that iron smelting is possible by means of poorer coke, raw coal, charcoal or electricity. A few blast furnaces in Scotland are using raw coal, a few in Sweden use electricity, one in South India (and probably a few in the United States of America) uses charcoal, but it is undeniable that the total amount of iron produced in all these put together is negligible in comparison with that produced in large-sized coke-fed blast furnaces. The essential fact in the survival of the raw coal or charcoal blast furnaces is the absence of coking coal in the areas in which they operate. The Mysore Iron Works will certainly not operate on charcoal if cheap coking coal were available within a reasonable distance. Neither will Sweden practise electric smelting generally if the country had not very cheap water power and had coal deposits which could be tapped. When good coking coal is available no iron-master will use any other type of fuel in his furnace, for the cheapest method of iron

smelting known at present is by means of coke. The industry could not have established itself in India but for the availability of good coking coal. Even then it has been found necessary to protect the industry to a certain degree, over a period of years, from the better organised foreign competitors. The reserves of high grade iron ore containing over 60 per cent. iron, within 150 miles or so of the fields producing coking coal, amount to something like 3,000 million tons. According to the estimates made by the Geological Survey of India (modified and brought up to date), the coking coals available in the Bengal and Bihar Fields amount only to about 1,400 million tons, *i.e.*, less than half the quantity needed to smelt this ore, even supposing that all the coal could be won and could be utilised for this purpose only. Ever since the invention of the coke blast furnace, more and more iron has been smelted in it and larger and larger units have been built. It is now thought that the optimum size of furnace has been reached and all who have practical experience assert that iron smelting is cheaper in large furnaces (with a daily capacity around 800 to 1,000 tons) than in small ones.

31. In this connection it will be pertinent to refer to the letter from the late Mr. C. P. Perin referred to in the Report (see page 75) in which he said that coal with as much as 36 per cent. volatile matter was being used by a coke-oven corporation in America and that the coke made therefrom was found to be ' fairly good ' for use in blast furnace. Such coal has also been tried in India but the coke was not found to be strong enough for use in large furnaces. There is no doubt that the use of weak coke will necessitate smelting in comparatively small sized furnaces, and this will increase the cost of smelting. Blending of Jharia coals with Raniganj coals has also been tried but the resultant coke is definitely weaker than coke made direct from Jharia coal. The representatives of iron and steel companies have definitely stated that coke made from such blended coal was found to be unsuitable for their purpose. They also stated that other processes are not commercially feasible under ordinary circumstances.

32. Knowing these facts it will be suicidal to exhaust our good coking coal by improper uses in the course of perhaps half a century or less and to have to look round for other ways of smelting, when a long-sighted policy will save that industry a good deal of anxiety and ensure a comparatively long supply of one of the essential raw materials. When such valuable, but limited, reserves are available, it behoves the State to look after their careful use and make them last for as long a time as possible. People who have contended that such a course is for the benefit of the steel industry do not seem to realise that this is a key industry entitled to every consideration and care by the State. Without a well-developed iron and steel industry no nation can become important and other industries dependent on it cannot properly flourish. Even the infant steel industry of India played an important part in supplying steel to the Middle Eastern theatres during the Great War.

33. Attention should be drawn here to the fact that the representatives of an important firm working the Dishergarh and Poniati seams of the Raniganj Field accused the Railways of wasting the coking coals of India by burning them in locomotives. They stated:—

> "It would appear to us from indications given, that one of the primary concerns of Government at the moment is the conservation of coking coal. In view of this, it seems remarkable to us that certain of the iron and steel companies should dissipate their resources of coking coal by sales to Railways and it seems even more remarkable that they are aided and abetted in this by the Government of India itself, the Railway Board Department of the Government of India being the chief purchaser of such coking coal.
>
> We would also represent that the coal areas owned by the Government of India and also by the Indian Railways, produce over 1,000,000 tons of coking coal per annum, the whole of which is used for steam raising. It would seem only sound conservation for the Government of India and the Indian Railways to stop this needless waste of coking coal, and substitute therefor supplies of the excellent steam coal available from the Raniganj coalfield. The coking coal thus conserved should eventually be of great value as a national asset, and surely the Government of India should not ignore its great responsibilities in this respect."

34. The ideas quoted above are worthy of note. But the railways have found by practical tests that the low volatile coals give them better service and are more economical to use, and they have therefore gradually discontinued using Dishergarh coal which at one time was thought to be the best coal in India for every possible purpose. It may, however, be pointed out that the representatives, whose remarks are quoted above, seem to have overlooked the fact that their own coal, which they obviously want to sell to the railways, is also of coking quality though the coke is not so strong as that from Jharia coal. Moreover, they export these, which are known to be the best gas coals of India, to countries outside and are, therefore, themselves no better than the Railways in the matter of the misuse of coking coal.

35. Another remedy suggested with regard to conservation of coking coals was that the steel industry should buy up enough reserves for their own consumption. This may be all right so far as the existing companies are concerned, but even they cannot visualise their own future development. Further, such a course does not make any provision for the requirements of future iron and steel companies which, considering the possibilities, are bound to come into the field, and such new companies will be at the mercy of the market.

36. Another proposal put forward by some of the witnesses, whose interests lie mainly in Jharia field, is that the Railways and the Iron and Steel Companies should stop raising coal from their

own collieries and purchase their requirements from other producers. This will certainly to some extent go towards conservation of coking coal, but there will still be a large amount of such coal raised and used for purposes other than metallurgical. Hence this suggestion will not solve the main problem.

37. In our opinion, these facts show conclusively that Government should acquire complete control over such an essential raw material as coking coal, in the first instance.

38. SUPERIOR NON-COKING COAL.—The arguments for the conservation of coking coal apply equally to non-coking coal of good quality, though perhaps with somewhat less force. For, non-coking coals of lower grade can to a large extent replace those of better grade by cleaning and beneficiation and by necessary adjustments in the furnaces, etc.

39. It is known that, just as the Jharia field is the chief storehouse of coking coal, the Raniganj field is the main source of high-grade, high volatile coal. The non-coking high volatile coals have their special field of uses such as carbonisation, gas manufacture, by-product recovery, chemical industries, hydrogenation, etc. These play a very important part in the industrial structure of advanced countries, but have, so far, scarcely received any attention in India. The important chemical industries designated "Coal Tar Industries" which include the manufacture of a great variety of products such as oils, synthetic dyes, high explosives, perfumes, antiseptics, medicines, etc., have a great future in India. Further, with the separation of Burma, India's petroleum reserves have become extremely limited, and in the near future hydrogenation and low temperature carbonisation of coal will have to be seriously taken up in India to meet the deficiency. The possibilities of hydrogenation may be illustrated by the fact that Germany, whose oil resources are limited, obtained, in 1936, about 53 per cent. of her oil requirements from domestic coal through this process. And in her 4-year plan it is proposed to treat 30 million tons of coal annually for the manufacture of motor spirit. In England also the Imperial Chemical Industries manufactured 34 million gallons of motor spirit in 1936 from 450,000 tons of coal, and other plants are in course of erection in South Wales. In Japan, low temperature carbonisation is absorbing 100,000 tons of coal per annum, with early prospects of expansion; and hydrogenation is being tried and will soon be run on a commercial scale. The above will indicate some of the special uses to which Raniganj coals may be put. If the high grade Raniganj coals are allowed to be depleted at the present rate, it is very likely that, by the time these industries are developed in India, there will be a shortage of such suitable coals, though to some extent some of the inferior Raniganj coals may be used.

40. It is well known that at present the greater part of the exports to countries outside India comprises the best Raniganj coals. From the conservation point of view it is just as highly objectionable to export Dishergarh and Poniati coal, as it is to use, say, XV or XVII seam Jharia coal for steam-raising. India has not a

surfeit of such high volatile coal of selected grade quality, and the necessity for conserving the same is, therefore, pressing. The *foreign market* is comparatively small, roughly only 200,000 tons per annum, and in our opinion the artificial stimulus to this export to foreign countries is not only not worth giving, but is definitely detrimental to the country's interest. The export is maintained at the sacrifice of Railway and Port Trust revenues amounting to something like Rs. 4,00,000 per annum in the shape of rebates. All that appears necessary and justifiable in India's interest is to encourage the distribution of Indian coal of suitable varieties within the country, *by land and by sea*, and at the same time to counter the imports of South African coal and other foreign fuels into India, and discourage competition with South Africa in foreign markets— a competition which we can ill afford to take up or sustain. Neither will the loss of markets absorbing a mere 2 lakhs of tons cause any serious dislocation of our coal trade, particularly as we shall thereby avoid a double sacrifice, *viz.*, export of some of our best coal from our limited reserve, and at the same time the sacrifice of revenue to the State. And if the trade is to be helped, it can well be given aid for the expansion of the internal market.

41. We have briefly analysed the major problems which confront Government in trying to regulate the coal industry, *viz.*, the difficulties with regard to mining thick seams and conservation in use.

42. The various facts and difficulties outlined above admit of only one solution, *viz.*, *State Acquisition of the Mines and minerals*. This should comprise, if not all the Bengal and Bihar fields, at least the Jharia and Raniganj fields in the first instance. The fields in the other provinces may be taken up later, as the urgency is not great in their case. The above two are the most important fields and contain the best coals in India and the problems to be faced there are acute. The major portion of the other important fields in the above-mentioned Provinces, *viz.*, Giridih and Bokaro, is already under State and Railway control. State acquisition is not an impracticable suggestion, as will be shown presently. We would, therefore, earnestly request the Government to examine this thoroughly as we feel confident that it is the only ultimate solution. The greater the delay in going into the matter, the greater will be the cumulative difficulties in course of time.

43. Advantages of State ownership.—The main advantages of the course recommended are:—

(i) Systematic development and working (in other words, *rationalisation*), are possible only under State ownership. The primary consideration of profit-making will be subordinated to sound mining methods. The putting out of fires, stabilisation, maintenance of a proper balance between production from pillar area and that from virgin area, can all be done without interference. Work can be done systematically and intensively in a few selected areas, resulting in economy. Stowing

operations can similarly be concentrated and made economical, and not diffused as will be the case under the scheme proposed by the Committee.

(ii) No question of the difficulties of section-working and of whether the coal raised is of commercial value can arise. Inferior coal can be beneficiated and properly prepared for the market.

(iii) Conservation in its broader aspect, *i.e.*, applied both to the reserves and to utilisation, is possible only under State ownership. Under private ownership waste in mining can perhaps be controlled, but waste in use cannot be controlled at all. In view of the limited reserves of good coal in the country, State ownership will be the only remedy and the cheapest from the national point of view.

(iv) The enormous quantities, running into 250 million tons of coal locked up under Railways, will be released because many of the sidings now in service can be closed, following concentration of work in a few selected areas.

(v) Considerable saving could be effected in the present "Colliery consumption" by extensive use of electricity which could be generated economically in central plants by means of inferior coal.

(vi) A proper balance between production and consumption can be kept up; over-production and cut-throat competition which are prominent features of the present market will be eliminated.

(vii) Questions which are a constant source of trouble under private ownership—*e.g.*, adjustment of boundaries, wayleave, small properties—will not arise under State ownership. Neither will the difficulties regarding the imposition of a cess arise, as the expenses of sand-stowing, where necessary, will form part of the working costs.

(viii) Even with all stringent safety measures, safety of life will not receive the full consideration it deserves, under private ownership, whose main objective is profit-making.

At present, one of the worst features of mining in India is the status of labour. Very little attention has been paid to their welfare and education, although education will go a long way towards ensuring safety. Under State ownership, labour will be better organised and looked after, as is the case, even now, in the State Railway Collieries as compared with the privately owned collieries.

(ix) The conflicting interests involved—large and small owners, European and Indian lessees, 'khas' and leased properties, etc.—will disappear.

(x) Under the present system, evasion and breaking of regulations are a permanent feature. With an increase in the number of regulations, as proposed by the Committee, a larger inspecting staff will be necessary to inspect properly the 600 coal mines in India and a corresponding increase in office staff and equipment. Under State ownership, this expenditure will be reduced because of the concentration of work in limited areas and the elimination of self-interest.

(xi) Under State ownership the consumer will be assured of getting the quality of coal suitable for his purpose at a reasonable price, and will, at the same time, be protected from unduly high prices which a combination of private enterprises might impose on the market.

44. ACTION PROPOSED.—Action with regard to State acquisition falls into certain definite steps:—

(1) In the first place, the coal areas which have hitherto been considered to be of no value should be declared as belonging to the State. Under this category will come all areas in which coal has not been proved so far, and properties in which no development has been done or contemplated. This will also apply to coal lying at depths of 3,000 feet and deeper, for no exploration has been done to this depth nor has any company included such coal under their probable reserves.

The above suggestion is similar to the recommendations made by the British Royal Commission on the Coal Industry (1925) (see pages 78-79 of Volume I of the Report of that Commission). They said:—

"There is one aspect of the question which is simple, and with regard to which the course is clear. It relates to coal which at present has no market value, and for which therefore no claim for compensation can arise.

"In this class, for instance, is coal the existence of which in workable quantities is unknown. The Kent coalfield was in this category not very many years ago. There may be coalfields in other parts of Great Britain that are still unsuspected. A person who owns land under which there is in fact workable coal, although no one knows that it is there, possesses no extra market value, above the value of his land for agriculture or other purposes, on account of the unsuspected presence of the coal. He loses no existing possession if the State, as an act of policy, legislates to the effect that all such coal shall vest in public ownership. What he loses is the possibility of a sudden unforeseen enrichment, if it should happen that coal were in fact to be found in the future under his land. We consider that it is in the public interest that legislation of this nature should be passed.

" In this category again is coal which is situated below the level of 4,000 feet (by the Ordnance Datum); this is now regarded as unworkable. Both the Royal Commission on Coal Supplies of 1871 and that of 1905 accepted that depth as the workable limit, and excluded from their estimates of the coal resources of the country all deeper levels. The Coal Conservation Committee of 1918 saw no reason to depart from that decision.

* * * *

" It would have been a lack of foresight if, in assuming the ownership of coal which now has no market value, the State had omitted this category from consideration. We recommend that it should be included.

* * * *

" With respect to other coal, we recommend that the principle of State purchase should be applied."

(2) *The Acquisition of Royalty Rights.*—The owners of coal lands in Bengal and Bihar are Zemindars under the Permanent Settlement. Between them and the actual operators there are frequently two or more intermediate lessees, each taking a share of the royalty. Most of the earlier leases have been given by the Zemindars on receipt of a lump sum payment (premium or *salami*), for periods up to 99 years (long lease) or up to 999 years (perpetual lease). At the present day they receive only a comparatively small sum as rent or royalty. Probably 60 per cent. of the coal areas are on leases of this description. The more recent leases are for shorter periods (varying from 20 to 50 years, with option of renewal) and at higher rates of royalty.

The present average royalties, including all the beneficiaries, are not more than 6 annas per ton of coal, calculated on despatches. Taking the annual despatches from the Bengal and Bihar coalfields as about 18 million tons, royalty on this will amount to Rs. 67,50,000. This, if capitalised at 20 times for the purpose of paying off the present owners, will give a figure of Rs. 13,50,00,000. Actually the capital needed will be less since some of the collieries are approaching exhaustion. A sum of Rs. 13,00,00,000 (Thirteen Crores) may, therefore, be taken as a fair estimate.

The above, *i.e.*, the purchase of royalty rights, is an essential preliminary to the acquisition of the mines themselves, and independent of it. It will enable the Government to assume the ownership of coal in place of the various private interests. Even in England, where private ownership of minerals is held sacrosanct, the Government have announced in Parliament (on 9th March 1937) the appointment of a tribunal presided over by a Judge to go into the question of the purchase price of all royalty rights, which now belong to numerous owners of surface lands. This step was recommended by the British Royal Commission on the Coal Industry of 1925 (see Chapter VII of the Report of that Commission).

This step will vest the Government, as owner of the mineral, with powers of supervision and control, which they do not possess at present, and which they can use without any interference. These powers are essential for the well-being of the industry and for ensuring both safety and conservation. The royalties can then be made uniform for each class of coal as far as possible, and can be unified and consolidated with the various rates and cesses now paid by the industry, reducing thereby the complexity and expenditure incurred on their collection.

It will be seen that the investment of a sum of Rs. 13,00,00,000 on the purchase of royalty rights will bring an annual return, in the shape of royalties, of Rs. 67,50,000. Whether the mines continue as private interests or are completely State-owned, the basis of royalty payment will remain; in the former case, it will be a direct payment by the lessees to the State, while in the latter, it will be included in the working costs and set apart as a separate item.

Assuming the above figures, this royalty will represent a rate of interest of 5·2 per cent. on the capital invested. At present, with plenty of money available in India at a rate of interest not exceeding 3 per cent., it will be easy for the Government to raise the loan of 13 crores and liquidate it in less than 50 years by setting aside 2 per cent., from the royalty receipts, towards redemption of capital. This would also allow for a sufficient margin for the costs of collection. After the liquidation of the loan, the income from royalties will be a direct source of revenue to the State and will continue as long as the coalfields last. It should be borne in mind that, with the industrial expansion in India resulting in greater demand for coal, income from royalties will increase in proportion and will enable the Government to liquidate the loan in an appreciably shorter period than that mentioned above. Hence the acquisition of royalties is definitely a paying proposition from the beginning and can therefore be taken up without delay.

(3) *Acquisition of coal mines.*—The next and final step is for the State to acquire the mines and thus eliminate the private interests completely. This is imperative and urgent in the case of at least the two most important fields, *viz.*, Jharia and Raniganj. This is, in our opinion, the only step which will save these two fields from the present dangers and rapid depletion and make conservation effective therein. After acquisition, the fires should be put out, the weak areas stabilised, and a systematic scheme drawn up for working intensively on sound and economic lines in selected and limited areas, accompanied by stowing wherever necessary, and the output of different qualities of coal regulated according to requirements.

The aggregate paid-up capital of Joint Stock Coal Companies working in India is computed at Rs. 10,45,05,969 in 1935-36 (see " Indian Coal Statistics, 1935 "). Excluding the mines in Nizam's Dominions and other Indian States, the amount will be about

Rs. 8,50,00,000. The capital invested by individual mine-owners and private syndicates may be taken as about Rs. 4,00,00,000, making up a total of Rs. 12,50,00,000 for the whole of British India. For the Bengal and Bihar fields alone, the valuation will probably not exceed Rs. 11,00,00,000.

We have taken into consideration the fact that there are some companies which are paying dividends and whose shares sell at a premium and therefore represent a higher value than the paid-up capital; but this will be more than balanced by the large number of non-dividend-paying companies whose shares are below par. These figures give an approximate idea of the cost, but the valuation will have to be done by a competent tribunal, taking all the various relevant factors into account.

The above sum represents the cost of acquisition of the mines in Bengal and Bihar, excluding the Railway Collieries. We are confining our attention to these fields because of their importance, and attention may be given to mines in other Provinces in due course.

In addition to the above, a further sum may be necessary for developing new properties, especially those bearing low grade coals, for the purpose of balancing up the restricted output of good quality coal, and for the reorganisation of the industry. A sum of Rs. 4,00,00,000 would probably suffice for this purpose, so that a total of Rs. 15,00,00,000 will be needed in connection with the acquisition of the mines. This can easily be raised by a loan in India carrying an interest of 3 per cent.

With the entire coal mining industry in the hands of the State, production and consumption can be co-ordinated and the prices regulated on quality so as to give an average net yield of 12 annas per ton (*i.e.*, over and above the cost of working including stowing, contribution to royalty charges, depreciation, workmen's compensation and welfare, etc.) on the despatches. The cost of coal on this basis should not cause any hardship to the consumer. It will be seen that the " net profit " on despatches of 18,000,000 tons will amount to Rs. 1,35,00,000 which will represent an yield of 9 per cent. on the capital investment. This income may be distributed as follows: 3 per cent. for interest charges, 3 per cent. for redemption of capital; and the remainder should compensate the Government for loss of revenue such as Income-tax and cesses which would have been derived from private owners had they continued to work the mines.

If, on detailed investigation, it is found that the capital cost of acquisition of the mines and minerals, or the interest on the loan raised is larger than that estimated by us, it will not materially affect our argument, for the price of coal can be regulated so as to cover the interest and other charges. An adjustment in the " net profit " per ton between the limits of 12 annas and Rs. 1-8-0 is probably all that will be necessary.

The Committee has remarked (Chapter XIII, page 170) that, apart from the financial difficulties, there would be practical difficulties in valuing the properties on account of the very large number of persons interested, and that the process of valuation will take 10 years. We have already dealt with the financial aspect and have pointed out that, under present conditions, there will be no difficulty in raising sufficient capital in India at low rates of interest. We also feel that the valuation of properties is no more difficult in India than in England or France, for it is stated that "on the average, each mine has had to obtain leases from no fewer than five mineral owners" (Volume I, Chapter VII, page 77 of the Report of the British Royal Commission on the Coal Industry, 1925). We have mentioned the fact that a Tribunal has already been set up in England for the valuation of the royalty rights. There are nearly 2,100 coal mines in Great Britain whose aggregate production is over ten times that of India.

A competent Tribunal aided by technical experts should be able to tackle the question of valuation successfully and expeditiously. We agree that it would take some time before the work could be accomplished, but it would require a much shorter period than 10 years. Whatever be the actual time taken by the Tribunal, once the Government declare their intention to acquire the mines and set up a Tribunal, this will immediately have the effect of encouraging the mine-owners (lessees) to run and maintain their mines in the best condition so as to be able to receive a good price.

The idea of State ownership is no innovation in India, as it is already at work in several important spheres of activity. More than half the railway mileage is owned and operated by the State, and the greater part of the remainder will be State property in the course of a few years. The forests are nationally owned and managed, and so are large irrigation works and hydro-electric projects. Even with regard to minerals, the State is the owner throughout India except in Bengal and Bihar. There is, therefore, every reason and justification for the State assuming the ownership of such a vital key industry as the coal industry. In fact, what we are recommending is the re-acquisition, on payment of a fair price, of what really once belonged to, and should have been retained by, the State.

We can best conclude by quoting the observations of the 1925 British Royal Commission on the Coal Industry (Volume I, page 78 of their Report):—

> "We are convinced that any unbiassed inquiry could not fail to lead to the conclusion that the private ownership of the minerals has not been in the best interest of the Community, and that it would have been very fortunate for the country if, three and a half centuries ago, when the judges decided that minerals, other than gold and silver, belonged to the surface owner, the legislature had reversed that decision, and reserved the coal to the State.

"The further consequence follows, that, if the existing system is wrong, it ought to be changed. The present generation should not be deterred by the difficulties that attach to the problem from undertaking to redeem the error of the past."

H. K. NAG.

M. S. KRISHNAN.

APPENDIX A.

SHORT ACCOUNTS OF ACTUAL COLLAPSES AND FIRES.

Case 1.—At a mine in Jharia where a considerable amount of coal has been lost, and where great difficulty in preventing collapses and controlling fires has been experienced, a section of the strata is as follows:—

No. 15 seam 28 feet coal, strata 9 feet,
No. 14 seam 8 feet coal, strata 50 to 100 feet,
No. 14 seam 28 feet coal, strata 60 feet,
No. 13 seam.

Workings in 15, 14-A and 14 seams have been made from the outcrops and extended towards the dip for a distance of about one mile. At the dip boundary, the cover to 15 seam is about 600 feet. Depillaring an area of 15 seam near the outcrop was followed by fire and, although very little coal in No. 15 seam was lost, an area in 14-A seam was lost containing 45,000 tons of coal and lying beneath the fire area. Several years after the commencement of this fire, the premature collapse of one or two small pillars in 14 seam permitted the fire to descend into that seam and over 500,000 tons of coal were lost. Shortly afterwards, the same fire made its way from 14 seam up through 80 feet of strata to 14-A and 15 seams in an area adjoining the area which had been previously sealed off, and a further loss of 200,000 tons of very good coal occurred.

Dispillarment of two small areas in 15 seam, where the cover was about 200 feet, was followed by spontaneous heating and about 290,000 tons of coal were locked up inside the stoppings isolating these areas.

The extraction of pillars in another part of 15 seam, where the cover was about 600 feet, proceeded normally until a fairly large goaf had been made, and 12 months after the commencement of depillaring spontaneous heating started in the goaf. Within the stoppings built to isolate the area, some 130,000 tons of coal had to be abandoned. Resumption was soon followed by crushing of large pillars and another fire ensued. To seal off this fire and prevent further over-riding of pillars, stoppings were built and a barrier was formed by sand-stowing. Inside the barrier 200,000 tons of coal in 15 seam had to be abandoned. This mine constitutes a striking example of how a fire in one seam can involve workings in lower seams, and how pillar extraction in some seams at certain mines by normal methods (that is without sand-stowing) will almost certainly be followed by fire or over-riding and a considerable loss of valuable coal.

Case 2.—At another mine in Jharia, where 14 seam is 26 feet and 13 seam is 16 feet in thickness, and the seams are separated by only 4 to 6 feet of shale, a considerable amount of coal has been lost or locked up by fires and premature collapses. After the extraction of some 70,000 tons of coal from pillars in 14 seam, over-riding and crushing of adjacent pillars commenced and involved the loss of 44,000 tons of coal in 14 seam and about 40,000 tons in 13 seam. Some months after this premature collapse, spontaneous heating commenced. At the same mine the extraction of some 40,000 tons of coal from pillars in another area of 14 seam was followed by crushing of adjacent pillars and a premature collapse which occasioned the loss of over 50,000 tons of coal in 14 seam and about 40,000 tons in 13 seam. Spontaneous heating in the same area was observed nine months later and, in order to close efficiently that area in both seams, some 300,000 tons of coal in 14 seam and 450,000 tons in 13 seam had to be locked up behind stoppings.

At the same mine, the extraction of pillars in 14 seam in two other areas was followed similarly by premature collapses and fires, and some 260,000

tons of coal in 14 and 13 seams were lost, while over 800,000 tons had to be locked up behind isolation stoppings.

The chief causes of loss of coal in this mine were the excessive height and width of galleries and the inadequate size of pillars in 14 seams, and the inadequate thickness of the parting between 14 and 13 seams.

This case exemplifies the impossibility of extracting pillars in a thick seam in an old mine by ordinary methods without excessive loss by fires and collapses, and it also demonstrates how coal can be lost in workings of a lower seam which are separated from workings in an upper seam by only a few feet of strata.

Case 3.—In a mine adjoining the last case with the same conditions, four separate premature collapses of pillars near the outcrop of 14 seam have occurred and involved the loss of some 115,000 tons of coal, but no spontaneous heating has taken place in the collapsed areas. This absence of fire is believed to be due to the fact that the collapses are close to the outcrop where a good quantity of cool air circulates through the broken areas and removes heat as it is generated.

Case 4.—In old workings of another mine in Jharia where the seam is 86 feet thick and dipping at 1 in 1·8, premature collapses and fire occurred involving the loss of a large section of the mine containing 3 million tons of coal. In addition to the coal entirely lost by fire in this area, a substantial barrier containing some 4 million tons of coal has to be left to protect new workings to the dip of the fire area. The causes of the premature collapses were friability of the coal, inadequate partings between sections, and small pillars.

Case 5.—The premature collapse of pillars in a seam 62 feet thick, dipping at 1 in 1·5, at another mine in Jharia was followed by fire. As galleries had been made from a quarry in several sections of the seam and the partings between the sections were thin, it was impossible to localise the fire and it spread eventually to all parts of the mine. The quantity of coal entirely lost was about 2 million tons. The amount of coal which may have to be locked up in a barrier to protect deeper workings from the fire area will be about the same quantity.

Case 6.—At another mine in Jharia in which a seam 60 feet thick and dipping at 1 in 2 was exploited by shallow shafts, inclines and quarries, a premature collapse was followed by fire and the whole of the connected workings were involved. The fire also involved the workings in a seam 7 feet thick and only 7 feet above the thick seam. The same fire subsequently broke through into an adjoining mine and involved all workings in the same two seams. The loss of coal in the two mines is estimated at 1·7 million tons.

Case 7.—The seams worked at a small mine in Jharia were No. 11-12 combined seam 48 feet in thickness and No. 10 seam 45 feet in thickness. The workings in the top seam were at a depth of 70 feet from the surface and the strata between the two seams measured 140 feet.

In the workings of the lower seam, some galleries were made excessively wide and, as the coal was friable, a premature collapse took place. About nine months later spontaneous heating started in the upper seam in the collapsed area and the whole mine had to be sealed. Although the sealing of the entrances into the mine was done satisfactorily, the fire was not arrested as it was able to obtain air from the surface through the broken ground. A year afterwards numerous subsidences occurred in other parts of the property and the fire became uncontrollable. It passed through attenuated barriers into four other mines and caused extensive damage to property on the surface as well involving the loss of some 1¾ million tons of coal in 11-12 seam. About 2 million tons of coal in 11-12 and 10 seams are also locked up by this fire.

Case 8.—A section of the strata at another mine in Jharia was as follows:—

No. 13 seam 20 feet coal, strata 85 feet,
No. 12 seam 12 feet coal, strata 8 to 32 feet,
No. 11 seam 22 feet coal, strata 110 feet, and
No. 10 seam 45 feet coal with bands of stone.

In this mine and in adjoining mines, 13 seam had been depillared and exhausted, and coal was being recovered from 10, 11 and 12 seams. The fire started at the face of a quarry in 13 seam owing to hot smalls and ashes from the manufacture of soft coke being thrown into the quarry. The fire spread very rapidly through the broken workings of 13 seam within this property and the adjoining properties. Goaves had already been made in 12 and 11 seams below the broken workings in 13 seam, and the fire spread to workings in these seams, through the goaves. In the course of two or three years, the whole of the workings in 11 and 12 seams of five collieries had been embraced by the fire and 2½ million tons of coal were lost. The fire has made the exploitation of 10 seam more difficult, dangerous and costly.

Case 9.—At another mine in Jharia the seam worked was No. 10 seam, 50 feet in thickness. The seam was worked in two sections, the galleries in the top section being up to 20 feet in height and those in the bottom section 15 feet. The centres of pillars were 40 to 50 feet apart and the galleries were 12 to 20 feet wide. Pillar-robbing rendered the pillars unstable and collapses took place involving the loss of some 200,000 tons of coal. The collapses have not been followed by spontaneous heating.

Case 10.—At another mine in Jharia the extraction of pillars near the outcrop in 15 seam of 25 feet thickness was followed by fire and some 600,000 tons of coal were lost behind stoppings isolating the area.

Case 11.—Two of the seams worked at another mine in Jharia were Nos. 14 and 13, 22 feet and 13 feet in thickness, and separated by only 8 feet of shale. Galleries in 14 seam were made 12 feet in width and the full height of the seam, while those in 13 seam were about 10 feet wide and 9 feet high.

The pillars in both seams were 35 to 40 feet square and the pillars in the upper seam were superimposed over those in the lower seam. After a large area of pillars had been extracted near the dip boundary in 14 seam where the depth of cover was about 170 feet, a premature collapse of an adjoining area in both seams took place. The quantity of coal lost was 300,000 tons. The collapse was not followed by fire.

Case 12.—A section of the strata at another mine in Jharia is as follows:—

No. 15 seam 27 feet coal, strata 8 feet,
No. 14-A seam 7 feet coal, strata 67 feet, and
No. 14 seam 28 feet coal.

Extraction of pillars with collapse in part of 15 seam workings resulted in fire which eventually involved all the workings in 15 and 14-A seams. The fire also descended through goaves into 14 seam workings where it was held in check for many years, but eventually involved the whole of the workings in that seam. The quantity of coal lost in the three seams is estimated to have been about 4,500,000 tons.

Case 13.—At a mine in Jharia a section of two seams is as follows:—

No. 14 seam 27 feet, strata 6 to 18 feet, and
No. 13 seam 18 feet.

The extraction of pillars in a fairly extensive area of the two seams resulted in a goaf fire which eventually involved all the workings in both seams in that section of the colliery. The fire has been a menace to the safety of adjoining mines for many years and has involved those mines.

in heavy expenditure on protective works. The quantity of coal lost by fire has been estimated to be about 1·4 million tons.

Case 14.—At another mine in Jharia, where No. 15 seam is 20 feet thick and lies at a depth of 300 to 450 feet from the surface, the extraction of pillars containing 40 to 60 per cent. of the coal in the seam resulted in the premature collapse of pillars over an extensive area. The collapse was not followed by fire because the area was allowed to fill with water. The collapse was due principally to the presence of faults and the inadequate size of pillars. The quantity of coal lost was 350,000 tons.

Case 15.—A section of the strata at a mine in Jharia is as follows:—

Strata 50 feet, No. 15 seam 21 feet coal (burnt and intruded by mica peridotite in many parts),

Strata 175 feet, No. 14 seam 27 feet burnt to jhamma,

Strata 13 feet and No. 13 seam 18 feet clean coal.

In this mine, although the galleries in 13 seam were wide, they were only 12 to 14 feet high and pillars were of a substantial size. Extraction of pillars was followed by heavy over-riding involving an extensive area and, despite the erection of numerous cogs and substantial brick pillars, the movement did not cease until it was arrested by dykes. A similar movement in another part of the mine was initiated by the extraction of about 14 pillars and this also did not cease until it was arrested by dykes and by very large pillars supporting shafts and a railway. The movement involved an area 1,400 feet × 1,300 feet. The loss of coal amounted to 895,000 tons.

The over-riding in both cases was due to the presence of strong mica peridotite sills and burnt seams in the superincumbent strata. The pillars surrounding the depillared areas were subjected to very abnormal loads and mass ground movements of great intensity because the sills and burnt seams prevented the normal breaking of the superincumbent strata with timely subsidence.

Case 16.—A section of the strata at another mine in Jharia is No. 15 seam top section 10 feet coal, strata 12 feet, No. 15 seam bottom section 8½ feet coal, strata 250 feet, No. 14 seam 28 feet coal, etc.

Pillars in both sections of 15 seam, in an area where the depth of the seams from the surface was small, were extracted by normal methods and no spontaneous heating ensued. Many years later, pillars in 14 seam below the same area were extracted and spontaneous heating started in the old goaves of 15 seam. This case is quoted to show that, although pillar extraction in a seam may not at the time be followed by fire, the extraction of pillars in a lower seam may cause a disturbance and admission of air to the old goaf, and so result in belated spontaneous heating. The quantity of coal locked up behind stoppings isolating this fire was about 200,000 tons.

Case 17.—In a subsidence of old workings close to the outcrop of a seam 18 to 20 feet in thickness in the Raniganj series, spontaneous heating started in December 1919 and the fire soon involved the whole mine. About 2 years later, the fire made its way through a barrier into an adjoining mine, but its advance there was retarded by isolation stoppings until 1925 when it made its way past the stoppings and involved the whole mine. During the course of three years, the original fire also passed through barriers into two other adjoining mines and within seven years it had completely involved five mines. The coal is of grade I quality in the high volatile series, and the seam was characterised by open joints and cleats along which the fire travelled through the barriers. The quantity of coal lost in the five mines was about 1½ million tons.

Case 18.—In a seam 19 feet in thickness in the Raniganj series, workings were made from inclines and shallow shafts over a very extensive area. As the mine was started early in the nineteenth century, the pillars in the old workings were small and numerous premature collapses occurred. Fires

followed the collapses and eventually the whole mine had to be abandoned. The loss of coal has been estimated at over 2 million tons.

Case 19.—At a mine in Raniganj a seam 18 feet in thickness was worked from inclines and shallow shafts over a very extensive area and the extraction of pillars was invariably followed by fire. The open cleats and breaks in the pillars, and the presence of broken workings in a seam 110 feet above, made control of the fires extremely difficult and eventually they got out of hand. The quantity of coal lost in this mine was about 500,000 tons, and 750,000 tons were locked up behind fire seals.

Case 20.—At another mine in Raniganj, a seam 16 feet thick lying at a depth of 400 to 900 feet was worked, extraction of pillars was started in 1921 and, in 1924 after 17 pillars had been extracted, a fire broke out. The fire was sealed off, but owing to crushing of pillars in the vicinity of the stoppings, and the almost unpreventable leakage of air into the area, the fire remained active and was a constant and serious menace to the mine and the workers employed therein. The fire resulted in the loss of 65,000 tons of coal. At the same mine, the extraction of an area of pillars 1,800 × 600 feet was followed by the premature collapse of pillars in an adjoining area and occasioned the loss of some 300,000 tons of coal. The pillars which collapsed contained more than 40 per cent. of the coal in the seam.

Case 21.—In a seam 27 feet in thickness in the Raniganj series with cover of about 100 feet, the extraction of pillars was followed by spontaneous heating. As galleries were of excessive dimensions, localisation of the fire was not possible and a large section had to be abandoned. A few months later, another fire started in the remaining section of the mine at a point where two or three pillars had collapsed some 8 months earlier and the whole mine had to be abandoned. The quantity of coal lost was 775,000 tons.

Case 22.—In a seam 15 feet in thickness in the Raniganj series, mining was commenced from the outcrop about 1870 and workings were made from shafts and inclines over a very extensive area. In the old workings, a high percentage of the seam was extracted in first working and, when pillar extraction was attempted, many premature collapses and fires ensued. The fires eventually got out of hand and the whole area had to be abandoned. The coal in a seam below the abandoned area had also to be locked up. The quantity of coal lost by fires and collapses is estimated to have been 1·1 million tons and the quantity locked up 1·8 million tons.

Case 23.—In a seam 28 feet thick in the Raniganj series, the collapse of a pillar surrounded by galleries made to the full height of the seam was followed two years later by fire. The extreme height of the galleries in the vicinity of the fire rendered the building of isolation stoppings extremely difficult, and a large portion of the workings had eventually to be enclosed in stoppings built in a railway barrier where the few galleries through the barrier were of small dimensions. The coal was grade I in the high volatile series. The fire involved the loss of 500,000 tons of coal.

Case 24.—The seam 17 feet in thickness is in the Raniganj series and 13 feet of the coal is graded in grade I. Fire broke out 8 months after a few pillars had collapsed in old workings lying at a depth of about 100 feet where 60 per cent. of the seam had been removed in the formation of pillars. Attempts to confine the fire to a small area were unsuccessful and the whole mine had to be closed and sealed at the surface. The quantity of coal locked up in the mine is about 2 million tons, but most of it is recoverable.

Case 25.—In a seam 16 feet in thickness in the Raniganj series, the extraction of pillars at a depth of 450 feet below the surface was followed by fires. A fall of roof in one large depillared area sealed off on account of fire caused the collapse of one or more fire dams and the expulsion of noxious and inflammable gases. The mine was abandoned. The quantity

of coal lost was about 1½ million tons of which about one million tons may be recoverable.

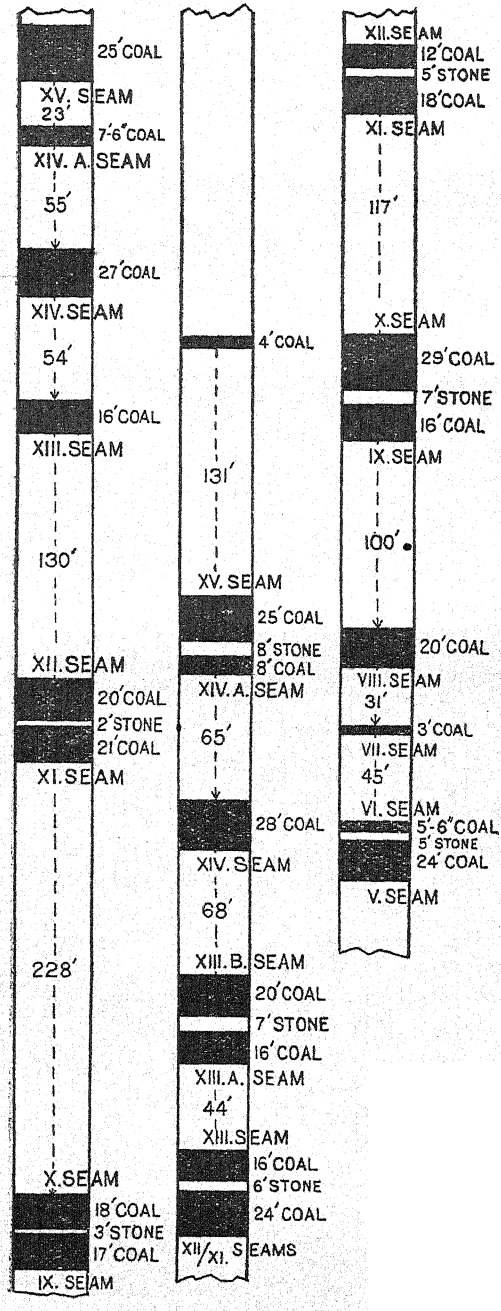
Case 26.—At another mine in Raniganj, where mining was commenced about 1867 from inclines and shallow shafts, two seams were exploited 12 and 18 feet in thickness and separated by 110 feet of strata. In the old workings the percentage of coal extracted in the formation of pillars was extremely high and, when extraction of pillars was commenced, coal was lost and fires ensued. Subsequent pillar extraction caused the collapse of pillars supporting stoppings round a fire area and the mine had to be flooded to overcome the fire which had involved the whole mine. The quantity of coal lost was about 400,000 tons.

It may be added that flooding a fire area is not always practicable because the necessary amount of water may not be available conveniently and also because the barriers between adjacent properties may not be able to hold the water if it is available. In one mine in Raniganj, the attempt to flood a fire led to the next mine being innundated and put out of action for about 6 months.

Case 27.—At another very old mine in which a seam 16 feet thick in the Raniganj series was worked at a shallow depth, pillar extraction resulted in numerous fires and eventually the fires got out of hand. The mine was abandoned and some 500,000 tons of coal were lost.

Case 28.—At another mine in Raniganj, where a seam 18 feet in thickness was exploited from inclines and shallow shafts, pillars were reduced until a collapse took place. Some years later a fire which started in the collapsed areas spread through the whole mine and also through two adjoining mines. The fire resulted in a loss of over 2 million tons of coal in the three properties.

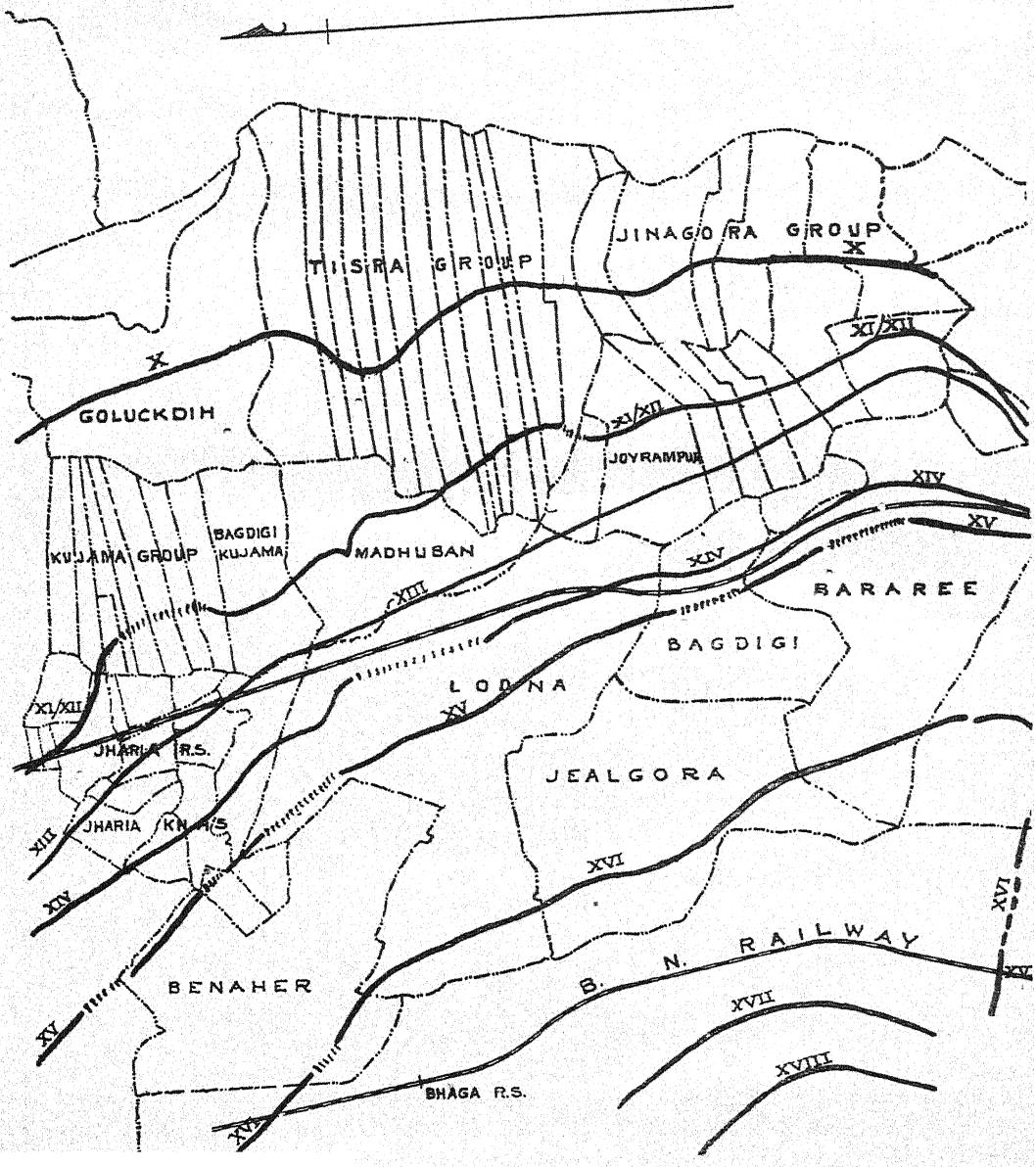
APPENDIX B.



SCALE 100 FEET = 1 INCH.

JHARIA

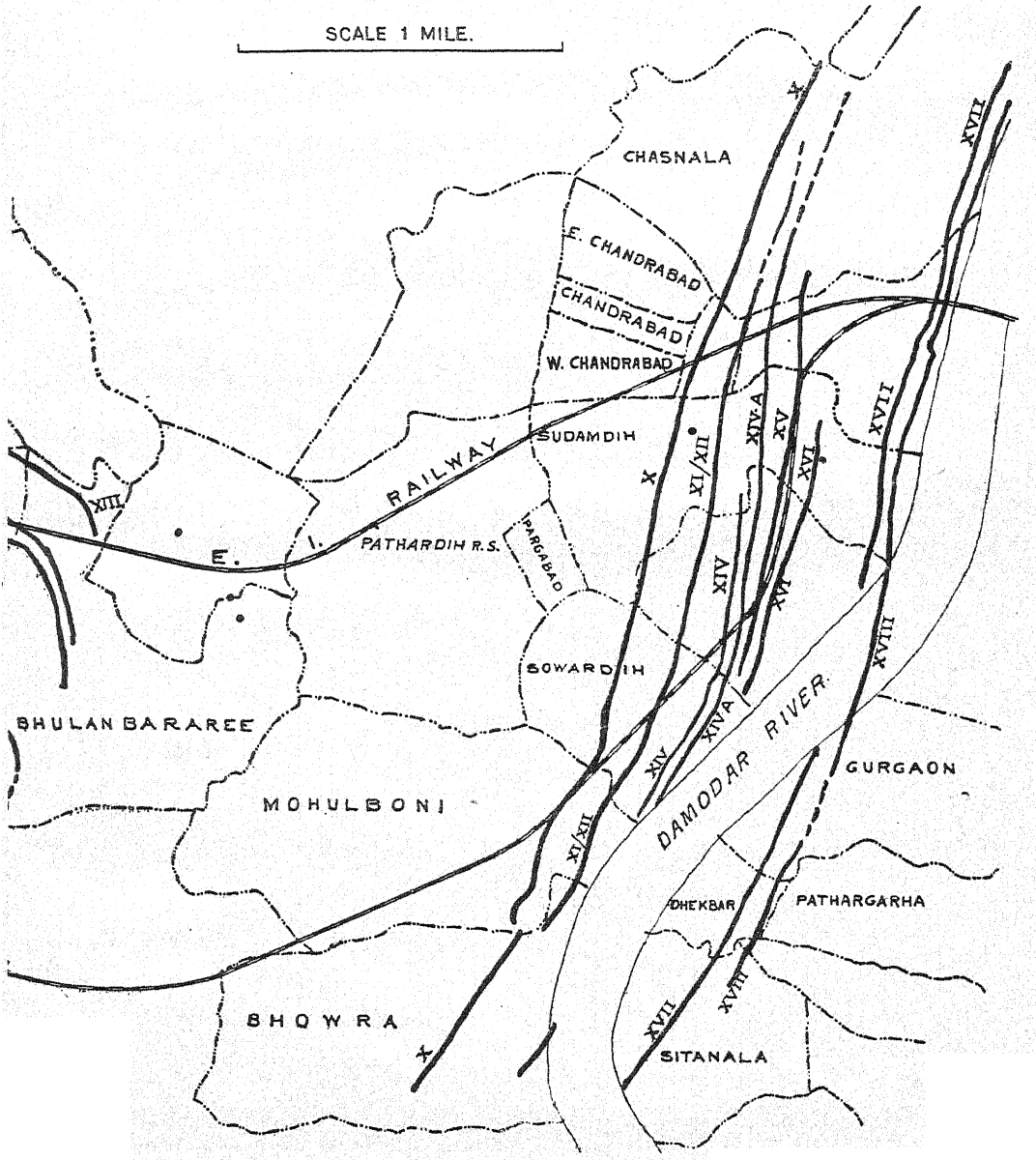
PLAN OF SOUTH-EAST SECTION SHOWING



DIX C.

COALFIELD.

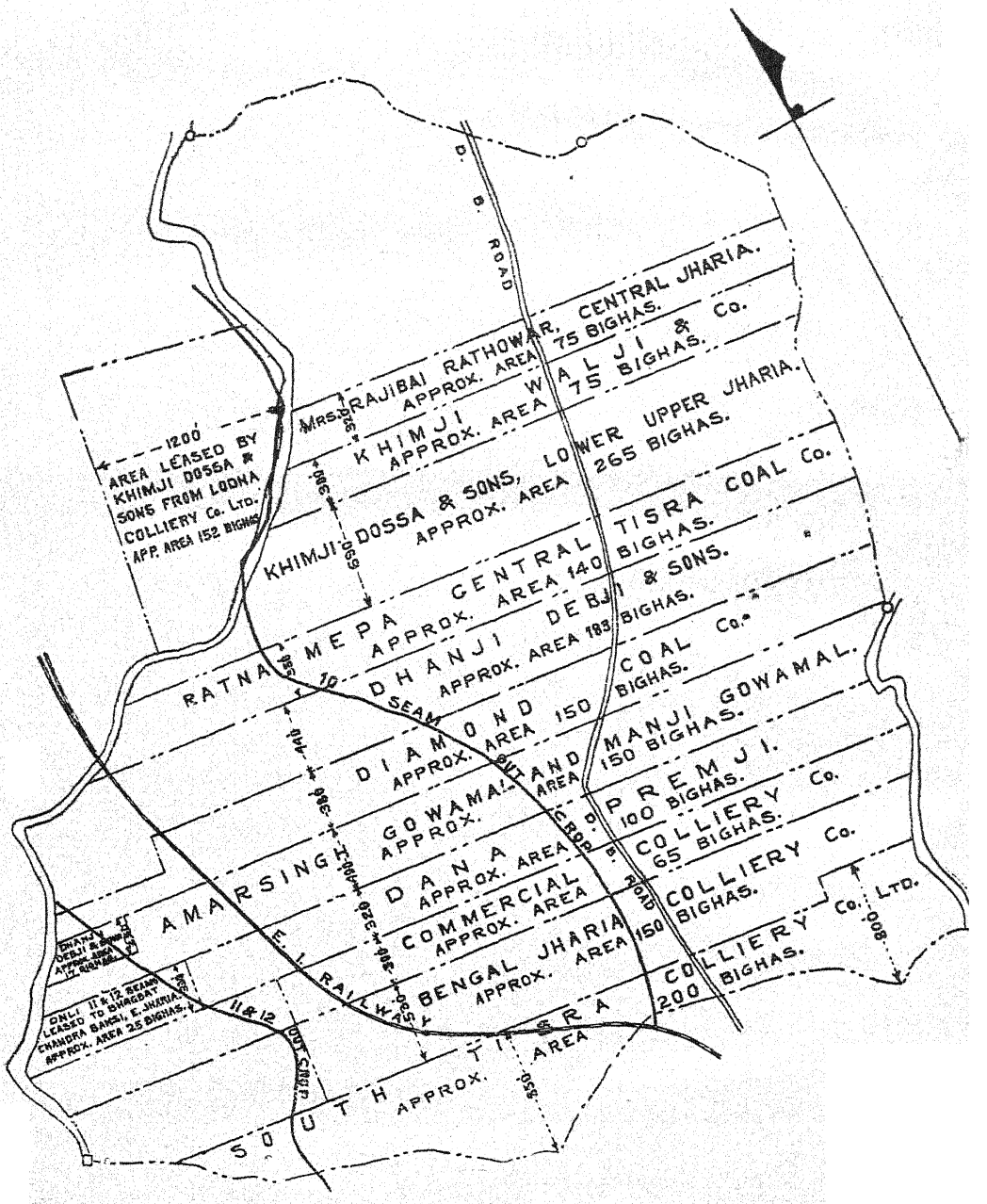
MOUZAS & SOME COLLIERY BOUNDARIES.



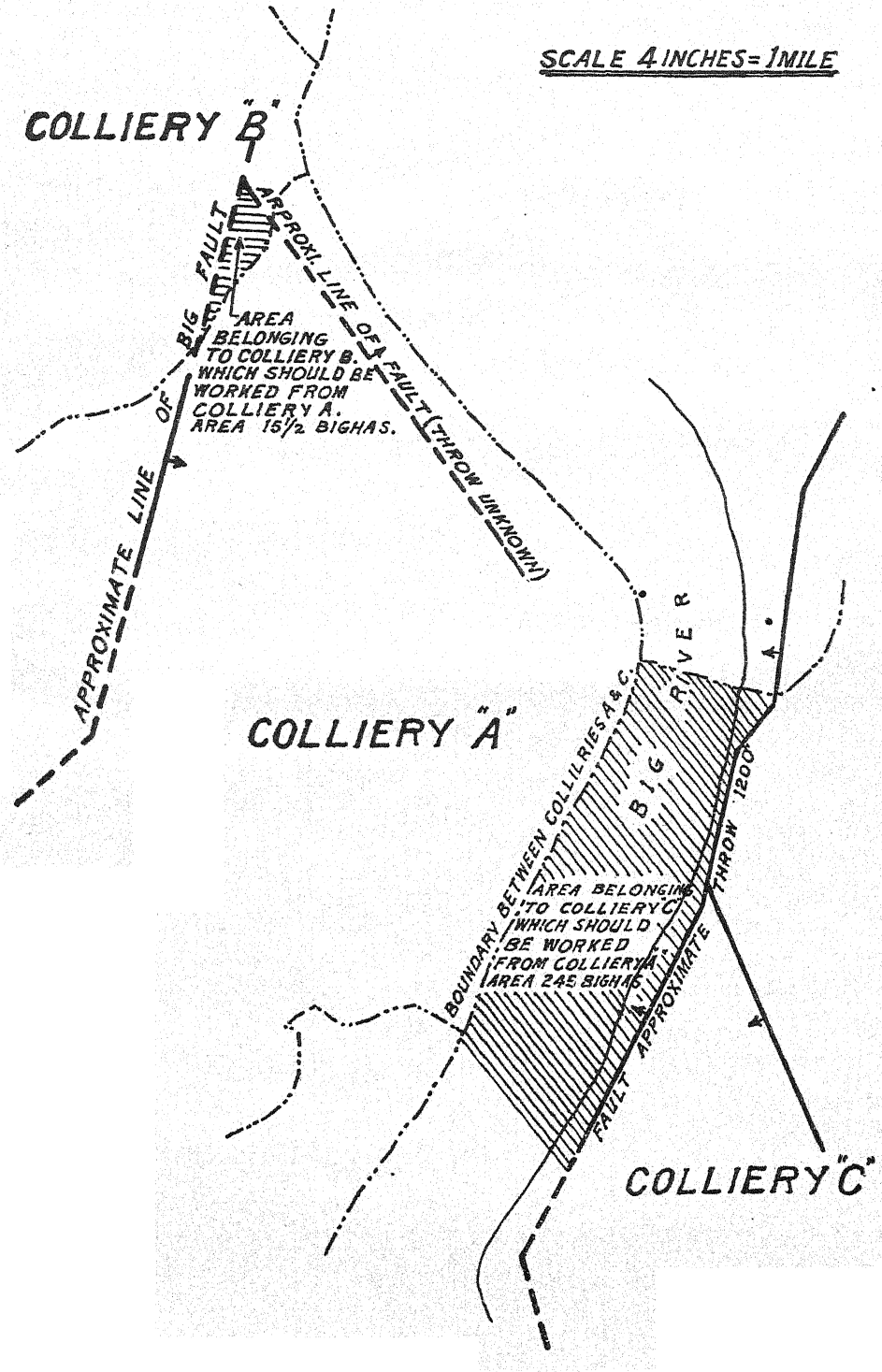
APPENDIX D.

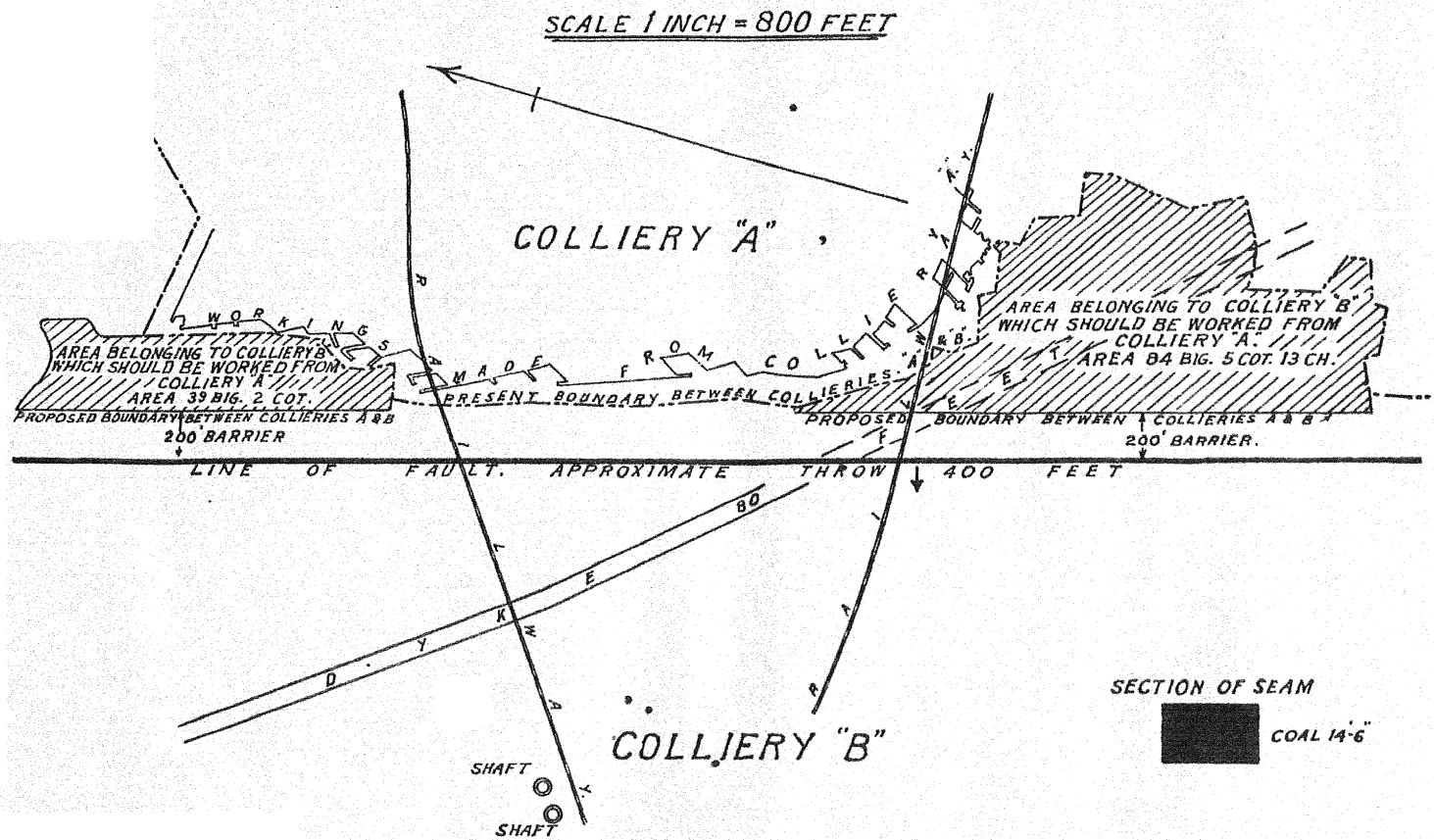
SKETCH PLAN SHOWING DISPOSITION OF COLLIERY PROPERTIES IN TISRA MOUZA

SCALE 1000 FEET.



APPENDIX E.


SCALE 4 INCHES = 1 MILE
COLLIERY "B"
APPROXIMATE LINE OF BIG FAULT
APPROXIMATE LINE OF FAULT (THROW UNKNOWN)
AREA BELONGING TO COLLIERY B. WHICH SHOULD BE WORKED FROM COLLIERY A. AREA 15½ BIGHAS.
APPROXIMATE LINE OF BIG FAULT
COLLIERY "A"
BIG RIVER
A
BOUNDARY BETWEEN COLLIERIES A & C.
AREA BELONGING TO COLLIERY C WHICH SHOULD BE WORKED FROM COLLIERY A AREA 24E BIGHAS
APPROXIMATE THROW 1200'
COLLIERY "C"


SCALE 1 INCH = 800 FEET
COLLIERY "A"
COLLIERY "B"
WORKINGS MADE FROM COLLIERY "A"
AREA BELONGING TO COLLIERY "B" WHICH SHOULD BE WORKED FROM COLLIERY "A"
AREA 84 BIG. 5 COT. 13 CH.
AREA BELONGING TO COLLIERY "B" WHICH SHOULD BE WORKED FROM COLLIERY "A"
AREA 39 BIG. 2 COT.
PRESENT BOUNDARY BETWEEN COLLIERIES
PROPOSED BOUNDARY BETWEEN COLLIERIES A & B
200' BARRIER
PROPOSED BOUNDARY BETWEEN COLLIERIES A & B
200' BARRIER.
LINE OF FAULT. APPROXIMATE THROW 400 FEET
SHAFT
SHAFT
SECTION OF SEAM
COAL 14'-6"

APPENDIX F.

TABLE I.—*Annual output (in tons) of the Jharia and Raniganj fields during the years 1920 to 1935.*

Year.	Jharia Coalfield.	Raniganj Coalfield.	Percentage of figure in Col. 2 to the total annual output in British India.	Percentage of figure in Col. 3 to the total annual output in British India.
1	2	3	4	5
1920 . .	9,294,040	4,997,679	54·41	29·26
1921 . .	10,059,649	5,211,845	54·79	28·39
1922 . .	9,936,299	5,203,214	54·69	28·64
1923 . .	10,346,015	5,557,424	55·14	29·62
1924 . .	10,845,642	6,035,347	53·54	29·80
1925 . .	10,676,883	5,729,686	53·47	28·69
1926 . .	10,373,736	6,124,884	51·63	30·48
1927 . .	10,583,487	6,472,036	50·14	30·66
1928 . .	10,665,479	6,460,490	49·57	30·03
1929 . .	10,785,745	6,828,053	48·35	30·61
1930 . .	10,753,858	7,218,691	47·41	31·82
1931 . .	9,755,037	6,530,713	47·55	31·83
1932 . .	8,551,283	6,419,007	45·68	34·29
1933 . .	8,014,949	6,265,703	44·13	34·50
1934 . .	9,057,546	6,795,838	44·74	33·57
1935 . .	9,245,292	7,348,323	43·99	34·97

TABLE II.—*Annual output (in tons) of superior (selected and grade I) and inferior (grade II and lower) coal from the Jharia coalfield during the years 1920 to 1936.*

Year.	Superior coal (in tons).	Inferior coal (in tons).	Percentage of superior coal.	Percentage of inferior coal.	Total output (in tons).
1920 .	6,608,633	2,685,407	71·7	28·3	9,294,040
1921 .	6,438,175	3,621,474	64·0	36·0	10,059,649
1922 .	5,892,503	4,043,796	59·3	40·7	9,936,299
1923 .	6,517,989	3,828,026	63·0	37·0	10,346,015
1924 .	7,244,889	3,600,753	66·8	33·2	10,845,642
1925 .	7,536,419	3,140,464	70·6	29·4	10,676,883
1926 .	7,427,595	2,946,141	71·6	28·4	10,373,736
1927 .	7,693,285	2,890,202	72·7	27·3	10,583,487
1928 .	7,903,120	2,762,359	74·1	25·9	10,665,479
1929 .	8,143,237	2,642,508	75·5	24·5	10,785,745
1930 .	8,269,717	2,484,141	76·9	23·1	10,753,858
1931 .	7,632,715	2,122,322	78·2	21·8	9,755,037
1932 .	6,652,898	1,898,385	77·8	22·2	8,551,283
1933 .	6,211,585	1,803,364	77·5	22·5	8,014,949
1934 .	6,992,426	2,065,120	77·2	22·8	9,057,546
1935 .	7,099,234	2,146,058	76·8	23·2	9,245,292
1936 .	6,678,768	2,109,084	76·0	24·0	8,787,852*

* There may be some change in the figures for 1936.

TABLE III.—*Annual output (in tons) of superior (selected and grade I) and inferior (grade II and lower) coal from the Raniganj coalfield during the years 1920 to 1936.*

Year.	Superior coal (in tons).	Inferior coal. (in tons).	Percentage of superior coal.	Percentage of inferior coal.	Total output (in tons).
1920 .	3,748,259	1,249,420	75·0	25·0	4,997,679
1921 .	3,882,825	1,329,020	74·5	25·5	5,211,845
1922 .	3,871,214	1,332,000	74·4	25·6	5,203,214
1923 .	4,229,200	1,328,224	76·1	23·9	5,557,424
1924 .	4,695,500	1,339,847	77·8	22·2	6,035,347
1925 .	4,554,933	1,174,753	79·5	20·5	5,729,686
1926 .	5,083,654	1,041,230	83·0	17·0	6,124,884
1927 .	5,598,311	873,725	86·5	13·5	6,472,036
1928 .	5,816,788	643,702	90·1	9·9	6,460,490
1929 .	6,199,872	628,181	90·8	9·2	6,828,053
1930 .	6,605,102	613,589	91·5	8·5	7,218,691
1931 .	6,021,317	509,396	92·2	7·8	6,530,713
1932 .	5,956,838	462,169	92·8	7·2	6,419,007
1933 .	5,852,167	413,536	93·4	6·6	6,265,703
1934 .	6,394,884	400,954	94·1	5·9	6,795,838
1935 .	6,966,279	382,044	94·8	5·2	7,348,323
1936 .	6,828,664	435,872	94·0	6·0	7,264,536*

* There may be some changes in the figures for 1936.

TABLE IV.—*Average value (per ton) at pitmouth of coal extracted from the mines in Jharia and Raniganj coalfields.*

Year.	Jharia.	Raniganj.	Year.	Jharia.	Raniganj.
	Rs. A. P.	Rs. A. P.		Rs. A. P.	Rs. A. P.
1920 .	4 10 0	6 2 0	1928 .	3 10 0	4 0 0
1921 .	5 12 0	7 8 0	1929 .	3 7 0	3 14 0
1922 .	6 14 0	9 5 0	1930 .	3 10 0	4 0 0
1923 .	6 13 0	8 13 0	1931 .	3 7 0	3 14 0
1924 .	6 12 0	7 13 0	1932 .	3 0 0	3 4 0
1925 .	5 13 0	6 11 0	1933 .	2 11 0	2 14 0
1926 .	4 9 0	5 5 0	1934 .	2 8 0	2 10 0
1927 .	3 15 0	4 6 0	1935 .	2 8 0	2 9 0

TABLE V.—*Average prices (per ton) of Indian coal (superior) at chief ports.*

Year.	Calcutta. Jharia selected delivered into wagons.	Calcutta. Dishergarh delivered into wagons.	Bombay.†† Dishergarh.	Karachi.†† Indian (trimmed into bunkers).
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
1920	6 8 6	8 12 10	32 3 8	33 10 2
1921	12 5 0	18 2 8	33 4 0	38 2 0
1922	11 2 0	14 8 0	33 8 0	35 6 8
1923	9 3 6	12 2 8	30 8 8*	35 0 0
1924	8 2 0	10 9 8	28 15 2*	29 2 8
1925	5 9 0	7 9 4	19 6 6†	23 2 8
1926	4 11 0	6 6 10	18 8 9†	21 4 10
1927	3 9 0	5 14 8	20 3 0†	21 10 11
1928	3 8 0	5 7 3	18 3 0†	19 5 4
1929	3 10 6	5 13 6	18 5 0†	19 4 0
1930	3 11 0	5 14 0	18 4 0†‡	19 0 8
1931	3 2 6	5 6 6	...	18 0 8
1932	3 4 6	4 10 4	15 5 4†§	16 15 4
1933	2 14 0	3 12 2	12 1 4||¶	14 11 0
1934	2 13 6	3 12 4	11 10 4**	13 8 8
1935	2 11 0	3 4 0	11 13 9**	14 7 0

NOTE.—The prices shown are based upon twelve-monthly quotations ruling at the beginning of each month.

* Bengal 1st class mill delivery.

† Ex-scales.

‡ Average for five months only.

§ Average for three months only.

|| C.i.f.

¶ Average for nine months only.

** Selected grade Jharia, net c.i.f. Bombay.

†† Prices include freight also.

TABLE VI.—*Exports of Indian coal* (in tons) by sea from 1920 to 1935.*

(Private Merchandise only.)

Year.	To Ceylon.	To Hongkong.	To Straits Settlements.	Total Indian Exports.
1920	685,559	...	228,355	1,224,758
1921	236,645	...	11,373	275,571
1922	76,742	...	...	77,111
1923	119,620	10	15,388	136,575
1924	170,701	...	17,763	206,483
1925	194,189	...	18,754	216,090
1926	243,263	2,085	117,469	617,573
1927	341,352	8,752	147,405	576,167
1928	352,602	110,701	73,389	626,343
1929	366,926	196,074	75,770	726,610
1930	282,590	61,885	26,367	461,188
1931	282,289	89,127	30,246	441,249
1932	190,834	219,490	13,357	519,483
1933	229,122	140,216	8,655	426,176
1934	228,559	56,737	35,647	330,233
1935	146,232	46,718	16,850	217,584
1936	148,597	5,038	16,660	195,836

* Excluding bunker coal and Government stores, but including coke and patent fuel.

TABLE VII.—*Quantity (in tons) of Indian coal* exported on private account as Cargo by sea (coastwise) from Bengal to other Indian ports (British and non-British) during each of the calender years 1926 to 1935.*

Year.	Quantity (in tons).	Year.	Quantity (in tons).
1926	1,435,110	1931	1,686,095
1927	1,682,802	1932	1,652,853
1928	1,633,518	1933	1,425,039
1929	1,860,602	1934	1,536,894
1930	1,556,569	1935	1,649,090
		1936	1,441,579

* Excluding coke.

TABLE VIII.—*Quantity (in tons) of foreign coal* imported into British India.*

(Private Merchandise only.)

Year.	From United Kingdom.	From Australia.†	From Union of South Africa.	Total import into British India.
1920	5,022	8,134	7,835	39,727
1921	441,305	111,384	306,968	1,090,749
1922	742,469	17,849	236,034	1,220,639
1923	131,739	59,380	281,793	624,918
1924‡	109,916	21,803	185,141	463,716
1925	124,111	7,495	204,189	483,160
1926	35,142	13,323	89,911	193,908
1927	55,903	11,017	133,827	243,603
1928	40,233	5,321	129,474	210,186
1929	33,786	1,043	176,376	218,560
1930	20,258	1,190	186,029	217,029
1931	29,974	3,400	48,716	88,035
1932	19,811	4,070	20,418	47,544
1933	11,174	4,248	45,258	67,330
1934	13,340	6,981	45,269	72,161
1935	13,022	2,624	42,314	77,075

* Figures exclusive of Government stores, but including coke and patent fuel.

† Includes figures for New Zealand up to 1924.

‡ Excludes figures for patent fuel from 1924.

TABLE IX.—*Quantity (in tons) of hard coke manufactured in India during the years 1920 to 1935.*

Year.	Production of hard coke.‡‡	Jharia coal.*	Giridih coal.	Raniganj coal.	Other coal.	Total coal used.	Quantity manufactured in coke-making plants.§§
1920	..	..	..	..	..	..	508,158§
1921	..	..	..	..	..	..	505,266§
1922	..	..	..	..	..	..	501,378‖
1923	..	..	..	..	..	..	799,956¶
1924	1,360,551	1,815,670	45,149	..	2,048	1,862,867	1,141,033**
1925	1,170,741	1,540,560	39,747	..	2,405	1,582,712	1,106,528**
1926	1,263,105	1,653,911	51,775	..	2,688	1,708,374	1,225,343**
1927	1,512,784	1,950,783‡	64,651	..	3,030	2,018,464	1,350,654**
1928	1,419,514	1,848,174‡	52,922	..	3,082	1,904,178	1,261,771**
1929	1,688,137	2,154,185	53,553	..	31,546	2,239,284	1,459,675**
1930	1,572,112	1,995,344	51,035	..	46,664	2,093,043	1,399,950**
1931	1,309,993	1,687,681	33,209	12,456	24,558	1,757,904	1,301,418††
1932	1,214,772†	1,585.733	32,724	12,878	7,330	1,638,665	1,216,039††
1933	1,227,746	1,517,483	27,245	110,469	2,898	1,658,095	1,230,319††
1934	1,517,137	1,934,048	26,297	80,924	2,698	2,043,967	1,518,896††
1935	1,766,821	2,232,807	26,740	91,035	2,859	2,353,441	1,759,036††

* Includes Raniganj coal also used by the Bengal Iron Co., accurate figures relating to which are not available.

† Excluding 271 tons produced from the Jarangdih colliery.

‡ Includes Bokaro-Ramgarh coal also used by the Indian Iron and Steel Co., Ltd., separate figures relating to which are not available.

§ Figures from 4 coke plants.

‖ Figures from 5 coke plants.

¶ Figures from 6 coke plants.

** Figures from 7 coke plants.

†† Figures from 8 coke plants.

‡‡ Geological Survey of India's figures.

§§ Chief Inspector of Mines' figures.

TABLE X.—*Quantity (in tons) of soft coke manufactured during the years 1920 to 1935.*

Year.	Jharia coalfield.	Giridih coalfield.	Raniganj coalfield.	Other coalfields.	Total.
1920	111,956	...	63,137	6,437	181,530
1921	71,730	...	74,737	4,814	151,281
1922	98,859	...	85,962	4,158	188,979
1923	113,464	...	101,443	5,154	220,061
1924	176,797	...	122,966	4,982	304,745
1925	290,807	26	120,644	4,492	415,969
1926	397,589	...	113,160	4,916	515,665
1927	500,812	...	104,229	3,571	608,612
1928	606,520	...	78,922	3,560	689,002
1929	693,186	...	60,134	4,407	757,727
1930	688,250	...	55,980	5,391	749,621
1931	676,976	...	43,639	3,561	724,176
1932	719,980	...	36,858	3,390	760,228
1933	784,429	...	36,572	3,164	824,165
1934	831,086	...	26,305	3,690	861,081
1935	845,453	...	35,749	9,345	890,547

TABLE XI.—*Reserves of Iron Ore.*

(Mainly after C. S. Fox—Trans. Min. Geol. Inst. India, XX, pp. 116-117; 1925.)

Ore.	Location.	Quantity (in million tons).	Composition. Fe.	P.	S.	Remarks.
	BIHAR-ORISSA.					
Hæmatite	Mayurbhanj	18	60-68	0·08	up to 0·6	Average ore despatched to smelting works at present contains 64 per cent. Fe, 2 per cent. silica, 1·25 per cent. alumina, 0·7 per cent. lime and magnesia, 0·05 per cent. P. and 0·02 per cent. S. The ore is within 150 miles of Jharia coalfield. Only these ores are now used by Tata Iron and Steel and Bengal Iron Companies.
	Bonai	648				
	Keonjhar	1,482				
	Singhbhum	1,043				
		3,191				
Hæmatite	Singhbhum and Orissa.	Probably 3,000	45-60	..	..	Large quantities of lower grade ores, probably of the same order as that of high quality, available.
	CENTRAL PROVINCES.					
Hæmatite	Baster	..	..	..	..	Quantity not known but will apparently run into several tons of million tons.
,,	Lohara (Chanda)	>100	61-67	0·005	0·012	Flux nearby, but Wardha valley coal is non-coking.
,,	Rajhara (Drug)	10	60	0·058	0·108	Flux at Dalli, but coke must be imported.
Laterite	Kankwara Hills (Jubbulpore).	49	53	0·146	0·02	Suitable for blast furnace, but lack of fuel.
	BENGAL.					
Ironstone	Raniganj coalfield	>400	38-46	0·09-04	Trace	Used by Bengal Iron Co. until 1913. Now unworked because excellent Singhbhum ore available.
Laterite	Rajmahal	..	43	0·6	..	Quantity not known but large. Former industry of Birbhum based on this ore.
	MADRAS.					
Magnetite	Kanjamalai (Salem)	>1,000	38-45	0·02-0·3	0·028	Ore is a mixture of magnetite and quartz. Amenable to magnetic concentration on fine crushing. May be eventually smelted by electricity, now available from the Mettur hydroelectric power station.
	MYSORE.					
Hæmatite	Babahudan Hills	50	60-64	0·03 to 0·05	0·03-0·04	Now being used in charcoal blast furnace of 80 tons maximum capacity at Bhadravati in Mysore.

TABLE XII.—*Production (in tons) of Iron Ore in India.*

Year.	Bihar and Orissa.	Mysore.	Burma.	Others.	Total.
1924 . . .	1,032,812	14,958	59,014	59,182	1,445,313
1925 . . .	1,435,558	56,218	51,617	1,185	1,544,578
1926 . . .	1,594,577	15,427	48,089	1,202	1,659,295
1927 . . .	1,736,060	48,465	61,062	1,148	1,846,735
1928 . . .	1,956,621	23,624	74,813	934	2,055,992
1929 . . .	2,337,344	45,937	46,140	715	2,430,136
1930 . . .	1,783,742	31,499	33,458	925	1,849,624
1931 . . .	1,599,386	18,517	1,886	5,092*	1,624,881
1932 . . .	1,744,247	4,394	6,560	5,299*	1,760,500
1933 . . .	1,154,396	35,041	36,293	2,895*	1,228,625
1934 . . .	1,853,116	38,974	23,930	898	1,916,918
1935 . . .	2,316,393	24,019	23,085	800	2,364,297

*Mainly from Madras. The other figures in the same column refer to production mainly from the Central Provinces. Taken from the Records of the Geological Survey of India relating to mineral production in India.

TABLE XIII.—*Production of Pig Iron, Steel and Ferro-Manganese (in tons) in India.*

—	Tata's.	Bengal Iron.	Indian Iron and Steel.	Mysore Iron Works.	Total.	Tata's Steel.	Tata's Ferro-manganese.
1924 . .	540,140	147,733	168,249	16,425	872,547	218,472	9,951
1925 . .	563,160	52,674	247,500	16,741	880,075	309,938	6,527
1926 . .	609,429	20,050	253,431	19,523	920,433	360,980	10,503
1927 . .	624,028	132,649	363,516	19,858	1,140,051	414,738	5,092
1928 . .	510,884	128,112	397,784	15,104	1,051,884	289,865	3,233
1929 . .	722,950	196,080	451,059	21,452	1,391,541	410,923	3,630
1930 . .	695,923	103,929	354,772	20,668	1,175,292	427,035	4,576
1931 . .	799,545	*Nil.*	243,214	15,577	1,058,336	439,134	14,366
1932 . .	699,931	*Nil.*	198,700	14,683	913,314	430,333	366
1933 . .	793,953	*Nil.*	249,079	14,805	1,057,837	505,429	7,725
1934 . .	882,054	*Nil.*	420,271	17,885	1,320,210	596,981	5,536
1935 . .	897,976	125,850	480,884	19,152	1,451,862	627,867	14,182

TABLE XIV.—*Exports of Pig Iron (in tons) from India.*

	1924.	1925.	1926.	1927.	1928.	1929.	1930.	1931.	1932.	1933.	1934.	1935.
United Kingdom .	8,828	28,708	15,314	21,140	8,920	43,905	116,762	51,600	85,332	82,823	106,867	69,120
Germany . . .	..	11,595	3,166	9,926	8,542	13,243	10,307	14,332	8,543	5,513	5,982	307
United States of America.	97,771	177,180	49,760	67,685	57,897	68,017	108,924	60,121	26,978	71,951	32,187	41,473
Japan . . .	149,697	158,713	230,913	265,226	321,010	385,158	201,997	157,116	101,983	179,506	212,285	334,267
China . . .	not available separately.					12,226	18,329	16,307	10,566	18,066	19,971	11,366
Other countries .	14,759	25,598	16,009	19,983	32,256	26,332	46,310	19,518	14,994	14,156	20,762	16,103
Total export—												
Tons . . .	271,055	401,794	315,162	383,960	428,625	548,881	502,629	318,994	248,396	372,015	398,054	472,636
(Value) Rs. . .	1,79,78,296	1,98,66,537	1,42,19,549	1,74,28,304	2,10,50,789	2,50,86,155	2,06,99,058	1,12,03,467	86,65,502	91,07,292	88,50,702	1,08,53,877
Total production in tons.	872,547	880,075	902,433	1,140,051	1,051,884	1,391,551	1,175,292	1,058,336	913,314	1,057,837	1,320,210	1,451,862
Export per cent. .	30·4	45·6	34·9	33·7	42·6	39·5	42·8	30·1	27·2	27·9	30·1	32·6

TABLE XV.—*Imports of Iron and Steel.*

		Cutlery and Hardware.	Machinery and Mill work.	Railway plant and Rolling stock.	Iron bars, Pig iron, etc.	Iron and Steel beams, pillars, sheets, etc.	Steel bars, angles, channels blooms, billets, etc.	Total value Rupees Lakhs.
1924	Rs.	5,72,36,344	15,53,44,993	8,93,15,058	32,46,182	16,68,06,548	3,55,87,206	50,21
	Tons	..	..	..	18,001	682,369	256,549	..
1925	Rs.	5,57,79,585	15,95,48,216	7,53,44,065	28,96,335	15,47,92,396	1,79,31,685	46,63
	Tons	..	..	..	17,775	668,920	147,788	..
1926	Rs.	5,58,83,246	15,13,37,077	7,14,94,159	23,12,530	16,63,32,509	2,41,14,554	47,15
	Tons	..	..	..	13,503	738,950	228,455	..
1927	Rs.	5,67,52,492	16,57,87,417	8,44,57,576	25,16,634	18,25,16,326	2,76,83,218	51,97
	Tons	..	..	..	19,455	871,813	260,389	..
1928	Rs.	5,85,55,191	21,04,39,807	2,21,41,648	20,75,394	18,81,48,943	2,66,84,083	50,80
	Tons	..	..	..	14,657	1,013,458	242,954	..
1929	Rs.	5,69,79,480	21,58,23,118		15,06,400	16,12,32,372	3,16,17,559	46,72*
	Tons	..	..		11,027	824,529	270,839	..
1930	Rs.	4,47,11,481	18,86,88,956		12,99,908	11,31,85,835	1,56,93,801	36,36*
	Tons	..	..		8,646	567,795	136,014	..
1931	Rs.	3,37,36,689	13,42,30,983		5,95,229	6,25,97,840	1,05,08,531	24,17*
	Tons	..	..		4,680	328,290	109,803	..
1932	Rs.	3,06,41,675	11,02,75,964	Not available.	6,54,627	4,65,90,979	81,19,873	19,63*
	Tons	..	..		4,721	329,000	91,330	..
1933	Rs.	3,19,63,976	12,87,40,082		7,94,299	4,52,56,932	76,73,776	21,44*
	Tons	..	..		6,418	238,559	73,573	..
1934	Rs.	3,29,87,547	11,74,50,797		7,21,467	4,99,92,606	94,83,479	21,06*
	Tons	..	..		6,444	256,595	84,712	..
1935	Rs.	3,40,37,964	13,35,71,208		3,59,907	5,79,43,157	87,18,398	23,46*
	Tons	..	..		2,768	313,781	81,233	..

* Excluding Railway plant and rolling stock.

Comparative Statistical Information (1919 and 1935).

	Particulars required.	In Raniganj.		In Jharia.		Total of columns 3 and 4.		REMARKS.				
1	2	3		4		5						
		1919.	1935.	1919.	1935.	1919.	1935.	1919.			1935.	
1	Total number of collieries .	305	191	335	206	640	397					
2	Number of collieries under development, but not raising coal.	44	8	9	4	53	12					
3	Number of collieries raising coal.	261	183	326	202	587	385					
4	Total annual output of collieries in serial No. 3.	6,800,844 tons.	7,348,323 tons.	12,036,137 tons.	9,245,292 tons.	18,836,981 tons.	16,593,615 tons.					
5	Number of collieries raising monthly—											
	(*a*) up to 1,000 tons .	137	70	151	62	*a* 288	132	*a* 49·06 p.c.	Of total number of 587.		34·29 p.c.	Of total number of 385.
	(*b*) over 1,000 and up to 5,000 tons.	92	84	121	97	*b* 213	181	*b* 36·28 ,,			47·01 ,,	
	(*c*) over 5,000 tons .	32	29	54	43	*c* 86	72	*c* 14·66 ,,			18·70 ,,	
6	Amount of annual output of collieries in—											
	(*a*) serial No. 5 (*a*) . .	540,721 tons.	218,814 tons.	651,192 tons.	351,906 tons.	*d* 1,191,913 tons.	570,720 tons.	*d* 6·33 p.c.	Of total output of 18,836,981 tons.		3·44 p.c.	Of total output of 16,593,615 tons.
	(*b*) serial No. 5 (*b*) . .	2,829,495 tons.	2,601,093 tons.	3,704,146 tons.	2,713,181 tons.	*e* 6,533,641 tons.	5,314,274 tons.	*e* 34·69 ,,			32·03 ,,	
	(*c*) serial No. 5 (*c*) . .	3,430,628 tons.	4,528,416 tons.	7,680,799 tons.	6,180,205 tons.	*f* 11,111,427 tons.	10,708,621 tons.	*f* 58·98 ,,			64·53 ,,	
7	Number of collieries raising coal by—											
	(*a*) hand labour only or mainly hand labour.	98	38	153	38	*g* 251	76	*g* 42·76 p.c.	Of total number of 587.		19·74 p.c.	Of total number of 385.
	(*b*) steam power only or mainly steam power.	160	135	165	150	*h* 325	285	*h* 55·37 ,,			74·03 ,,	
	(*c*) electric power only or mainly electric power.	3	10	8	14	*i* 11	24	*i* 1·87 ,,			6·23 ,,	

	Amount of annual output of collieries in—										
	(*a*) serial No. 7 (*a*) . .	438,044 tons.	67,754 tons.	1,023,865 tons.	207,319 tons.	*k* 1,461,909 tons.	275,073 tons.	*k* 7·76 p.c.	Of total output of 18,836,981 tons.	1·66 p.c.	Of total output of 16,593,615 tons.
	(*b*) serial No. 7 (*b*) . .	6,044,141 tons.	6,015,787 tons.	9,900,836 tons.	*c* 919,278 tons.	*l* 15,944,977 tons.	*r* 12,935,065 tons.	*l* 84·65 ,,		77·95 ,,	
	(*c*) serial No. 7 (*c*) . .	318,659 tons.	1,264,782 tons.	1,111,436 tons.	2,118,695 tons.	*m* 1,430,095 tons.	3,383,477 tons.	*m* 7·59 ,,		20·39 ,,	
9	Number of raising collieries worked by—										
	(*a*) limited companies .	114	83	101	74	215	157				
	(*b*) private owners . .	147	100	225	126	372	226				
10	Amount of annual output of collieries in—										
	(*a*) serial No. 9 (*a*) . .	*l* 5,241,860 tons.	5,940,020 tons	7,659,623 tons.	6,464,143 tons.	*n* 12,901,483 tons.	12,404,163 tons.	*n* 68·49 p.c.	Of total output of 18,836,981 tons.	74·75 p.c.	Of total output of 16,593,615 tons.
	(*b*) serial No. 9 (*b*) . .	1,558,984 tons.	1,408,303 tons.	4,376,514 tons.	2,781,149 tons.	*o* 5,935,498 tons.	4,189,452 tons.	*o* 31·51 ,,		25·25 ,,	
11	Average daily number of persons working—										
	(*a*) above and below ground.	59,219	55,592	95,276	66,992	154,495	122,584	..	Of total number of workers.	..	Of total number of workers.
	(*b*) above ground . .	22,940	15,411	37,608	21,493	*p* 60,548	36,904	*p* 39·19 p.c.		30·11 p.c.	
	(*c*) below ground . .	36,279	40,181	57,668	45,499	*q* 93,947	85,680	*q* 60·81 ,,		69·89 ,,	
12	Output per person employed—										
	(*a*) above and below ground.	114·84 tons.	132·18 tons.	126·33 tons.	138·91 tons.	..	..				
	(*b*) below ground . .	187·45 tons.	182·88 tons.	208·71 tons.	203·19 tons.	..	..				
13	Number of collieries making coke in—										
	(*a*) open ovens . .	95	23	204	162	299	185				
	(*b*) by-product ovens .	1	2*	2	4	3	6	* 1 is at the Bengal Iron and Steel Works, Kulti, and 1 is at the Indian Iron and Steel Works, Hirapur, Burnpur.			
14	Number of collieries in which hydraulic stowing has been introduced for pillar recovery in old workings.	4	2	1	3	5	5	In addition packing is being done in several mines in both the Jharia and Raniganj coal-fields to stabilise areas of weak pillars.			

* Supplied by the Mines Department.